CHAPTER 10. SHIPMENTS ANALYSIS

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CHAPTER 10. SHIPMENTS ANALYSIS

10.1 INTRODUCTION

Lamp shipment estimates are key inputs to the national energy savings (NES) and net present value (NPV) calculations. Shipments are also a necessary input to the manufacturer impact analysis (MIA), which the U.S. Department of Energy (DOE) conducts for its Notices of Proposed Rulemaking (NOPRs). This chapter describes DOE's methodology for projecting annual shipments and presents initial inputs and results for general service fluorescent lamps (GSFL) and incandescent reflector lamps (IRL)

In the shipments analysis, DOE develops a base case shipment forecast for each lamp type to depict what would happen to energy use and consumer costs for the purchase and operation of lamps in the absence of new or revised Federal energy conservation standards. In determining the base case, DOE considers historical shipments, emerging technologies, the mix of efficacies sold in the absence of any new or revised standards, and how that mix might change over time. To evaluate the impacts of standards on GSFL and IRL, collectively referred to in this rulemaking as the "two categories of lamps," DOE compares the base case projection with forecasts of what could happen if DOE promulgates standards (the standards-case). DOE considers multiple shipments scenarios to characterize both the base case and standards-case shipments. To determine the cumulative NES and NPV of standards, DOE compares forecasted shipments of a base case to a standards-case over the NIA analysis period, 2012 to 2042.

The shipments model and the national impacts model are integrated into single Microsoft Excel® spreadsheets for GSFL and IRL. The two spreadsheets are accessible on the Internet at http://www.eere.energy.gov/buildings/appliance_standards/. Appendix 11A discusses how to access the spreadsheets and provides basic instructions for using them. This TSD chapter explains the shipments models. Section 10.2 presents the shipments model methodology for GSFL and IRL; section 10.3 describes the data inputs, historical shipments, base case scenarios and shipments forecasts; section 10.4 discusses the impacts of standards on the mix of lamp designs and lamp-and-ballast designs; and section 10.5 presents the shipments results for the different trial standard levels (TSLs).

10.2 SHIPMENTS MODEL METHODOLOGY

In this NOPR, DOE develops separate shipment models for GSFL and IRL. In general, to forecast shipments for these two categories of lamps, DOE followed a four-step process. First, DOE used 2001-to-2005 historical shipment data from the National Electrical Manufacturers Association (NEMA) to estimate the total historical shipments (i.e., NEMA member and non-NEMA member shipments) of each lamp type analyzed, except for 4-foot T5 MiniBP standard output and high output lamps, as explained in section 10.3.2.2.[1] Second, DOE calculated an installed stock of lamps for each lamp type in 2005, based on the average service lifetime of each lamp type. Third, by modeling lamp purchasing events, such as lamp replacement and new construction, and applying growth rate, replacement rate, and emerging technologies penetration rate assumptions, DOE developed annual shipment projections from 2006 to 2042. DOE also calibrated its shipments model to reflect confidential shipment data provided by NEMA for 2006 and 2007. Finally, because the shipments of lamp designs and lamp-and-ballast designs (for GSFL) often depend on their properties (e.g., ballast factor, efficacy, etc.), DOE developed base case and standards case market-share matrices as another model input. The market-share matrices characterize the efficacy, power rating, light output, and lifetime of the lamp and lamp-and-ballast designs. The matrices input the percentage market share of each design into the shipment model. DOE used these market-share matrices to forecast lamp stock and shipments, taking into account each design's respective lifetime, and to determine the aggregate characteristics of the market (e.g., average light output, efficacy, energy consumption, and power rating).

10.2.1 General Service Fluorescent Lamps

10.2.1.1 Analyzed Product Classes, Market Sectors, and Market Segments

Consistent with observed market applications, DOE forecast annual shipments for 4-foot medium bipin lamps in the residential and commercial sectors, 8-foot single pin slimline and 4-foot T5 MiniBP standard output (SO) lamps in the commercial sector, and 8-foot recessed double contact high output (HO) and 4-foot T5 MiniBP high output (HO) lamps in the industrial sector. The shipments model analyzes all lamp types at TSLs which assign efficacy levels for each product class. For further detail on the TSLs, see chapter 9 of this technical support document (TSD).

As it relates to 2-foot U-shaped lamps, DOE did not directly model their shipments because of their relatively small shipments-based market share (approximately 4 percent). Given the similarity of the 4-foot medium bipin and U-shaped product classes with regard to system input power and historical shipment trends (which show a decrease in T12 lamps and an increase in T8 lamps), DOE scaled the results from the 4-foot medium bipin product class to approximate the NES and NPV of 2-foot U-shaped product class. Because historical shipments of 4-foot medium bipin lamps were 22 times that of 2-foot U-shaped lamps, DOE used this scaling factor to approximate the energy savings and net present value for 2-foot U-shaped lamps.

In addition, because GSFL of different correlated color temperatures (CCTs) were not segregated in the NEMA historical shipment data, DOE decided to analyze and forecast shipments of each lamp type (*e.g.,* 4-foot medium bipin), and aggregate lamps of low (less than or equal to 4,500K) and high (greater than 4,500K) CCT. In each case, DOE uses a representative product class (lamps with CCT less than or equal to 4,500K) to evaluate lamp designs and believes that the national impacts will be similar for those product classes not directly analyzed (lamps with CCT greater than 4,500K). By aggregating the low and high CCT product classes, DOE assumes that there will be no significant migration of shipments or stock between lamps of different CCTs.

In its GSFL shipment model, DOE considers specific market segments, or lamp purchase events, to develop estimates of annual shipments. In the shipments model, DOE accounts for the four market segments that correspond to the lamp purchase events that DOE uses in the life-cycle cost (LCC) and payback period (PBP) analyses in Chapter 8. These include: lamp failure (Event I), ballast failure (Event III), lamp-and-ballast system retrofit (Events II and IV), and new construction (Event V). For each market segment, DOE makes certain assumptions about how consumers are likely to purchase new lamps or lamp-and-ballast systems. DOE uses these purchasing assumptions to develop the GSFL shipment forecasts.

10.2.1.2 Lamp Replacement

For those consumer purchases triggered by a lamp failure, DOE assumes that the consumer will purchase a lamp identical to the one that has retired, if it is available. If in the standards-case, the base case lamp design is not standards-compliant (and therefore unavailable as a replacement option), then DOE assumes consumers will purchase a new lamp that is compatible with the existing ballast. If no standards-compliant lamps are compatible with the consumer's existing ballast, DOE models consumers as retiring their lamp-and-ballast system before the ballast's end of life. The consumer's purchase decision is then identical to that of a lamp-and-ballast system retrofit.

DOE establishes the timing of lamp replacements by tracking the shipments of lamps and then predicting when lamps will retire based on their average service lifetime. Instead of using each particular lamp design's individual lifetime, DOE uses the each lamp's lifetime and the estimated distribution of lamp shipments by lamp design to establish an average lifetime for each lamp type. DOE then used the distribution of operating hours in each sector (discussed in the Energy Use Characterization, chapter 6 of this TSD) to predict the probability of lamp failing in any given year. Based on this probability, DOE calculates the quantity of lamp shipments required for lamp replacement,

10.2.1.3 Lamp-and-Ballast System Replacement (Ballast Failure and System Retrofit)

For consumer purchases triggered by a ballast failure or lamp-and-ballast system retrofit, DOE assumes that consumers will discard their existing lamps with the failed ballasts, even if lamp life remains. Consumers will then purchase new lamp-and-ballast systems compatible with their existing fixtures to replace their retired system.

Historical shipments and discussions with industry experts indicate that there are several lamp-and-ballast replacement and retrofit trends within the GSFL market. DOE models these trends in both the base case and standards-case shipment models. For example, in the commercial sector, DOE models a natural shift upon ballast retirement and replacement from 4-foot T12 medium bipin magnetic ballasts (1- and 2-lamps per ballast systems) to 4-foot T8 medium bipin electronic ballasts (3-lamp per ballast systems). Specifically, DOE assumes 90 percent of commercial 4-foot T12 medium bipin magnetic systems are replaced with 4-foot T8 medium bipin systems and 10 percent are replaced by 4-foot T12 medium bipin electronic systems. In the residential sector, DOE modeled a shift from 4-foot T12 magnetic ballasts to both 4-foot T12 magnetic systems and electronic systems in the base case, and, in the standards-case, to 4-foot T8 systems as well. Specifically, in the residential base case, half of retiring 4-foot T12 magnetic systems are replaced by the same system, while the other half are replaced by 4-foot T12 electronic systems. In the residential standards-case, as discussed in Section 10.4.1.3 and shown in Table 10.56, 4-foot T8 systems begin to penetrate this market segment; they replace 25 percent, 35 percent, and 60 percent of the retiring 4-foot T12 magnetic systems at TSL1, TSL2, and TSL3, respectively (T12 lamps are non-compliant at TSL4 and TSL5 and therefore all T12 systems are replaced with T8 systems at TSL4 and TSL5). Half of remaining 4-foot T12 systems shipped at TSL1, TSL2, and TSL3 are magnetically ballasted and have are electronically ballasted.

Similarly, in the commercial sector, DOE models a shift from 8-foot T12 single pin slimline magnetic ballasts to 8-foot T8 and 8-foot T12 single pin slimline electronic ballasts, as well as a system of two 4-foot T8 medium bipin electronic ballasts. Specifically, DOE assumes 80 percent of retired 8-foot T12 single pin magnetic systems are replaced by two 4-foot T8 medium bipin systems, 10 percent by 8-foot T8 single pin systems, and 10 percent by 8-foot T12 single pin electronic T12 systems.

Table 10.1 below presents the modeled lamp-and-ballast replacement trends. DOE also modeled early (voluntary) retirement of lamp-and-ballast systems in the standards-case. Section 10.4.1.3 provides more details on the assumptions DOE makes regarding these retrofits.

Table 10.1 Modeled GSFL Lamp-and-Ballast Replacement Trends

Retired Lamp-and-Ballast System	Replacement Lamp-and-Ballast System
4-foot T12 medium bipin (Commercial Sector) (1- and 2-lamp per ballast system)	90% 4-foot T8 medium bipin (3-lamp per ballast system)
	10% 4-foot T12 electronic medium bipin (one- and 2-lamp per ballast system)
4-foot T12 magnetic medium bipin (Residential Sector) (1- and 2-lamp per ballast system)	50% 4-foot T12 electronic medium bipin (one- and 2-lamp per ballast system)
	50% 4-foot T12 magnetic medium bipin (one- and 2-lamp per ballast system)
4-foot T8 medium bipin (3-lamp per ballast system)	4-foot T8 medium bipin (3-lamp per ballast system)
8-foot T12 single pin slimline (2-lamp per ballast system)	10% 8-foot T8 single pin slimline (2-lamp per ballast system)
	10% 8-foot T12 single pin slimline (2-lamp per ballast system)
	80% 4-foot T8 medium bipin (two 2-lamp per ballast systems)
8-foot T8 single pin slimline (2-lamp per ballast system)	8-foot T8 single pin slimline (2-lamp per ballast system)
8-foot T12 recessed double contact HO (2-lamp per ballast system)	8-foot T12 recessed double contact HO (2-lamp per ballast system)
8-foot T8 recessed double contact HO (2-lamp per ballast system)	8-foot T8 recessed double contact HO (2-lamp per ballast system)
4-foot T5 miniature bipin SO (2-lamp per ballast system)	4-foot T5 miniature bipinSO (2-lamp per ballast system)
4-foot T5 miniature bipin HO (2-lamp per ballast system)	4-foot T5 miniature bipin HO (2-lamp per ballast system)

DOE establishes the timing of ballast replacements in response to ballast failure by tracking ballast shipments and then predicting when these ballasts are expected to retire based on their service lifetime. DOE calculated average commercial and industrial ballast service lifetime by dividing the average ballast lifetime in hours (established in the LCC) by average operating hours. The service life in the commercial and industrial sectors is 14 years and 10 years, respectively. For the residential sector, DOE used a 15-year service life, consistent with measured life studies.

10.2.1.4 Lamp-and-Ballast System New Purchase (Fixture Replacement, Renovation, and New Construction)

Finally, for consumer purchases triggered by fixture replacement, renovation, and new construction, DOE assumes that consumers may purchase a variety of new lamp-and-ballast systems to service their particular lumen demand. Because historical shipment data have shown significant growth for only 4-foot T8 medium bipin and 4-foot T5 miniature bipin SO systems, DOE models all purchases due to new construction in the commercial sector as being one of these two lamp-and-ballast systems. In the residential sector, DOE models only 4-foot medium bipin systems for new construction. In the industrial sector, confidential historical shipments show a declining number of 8-foot recessed double contact HO lamps. Therefore, DOE assumes that all system purchases due to new construction in the industrial sector are either 4-foot T5 miniature bipin HO systems (another rapidly growing market) or other emerging substitution technologies (e.g., light emitting diodes).

DOE modeled 4-foot T5 MiniBP SO and HO shipment growth based on a migration from other product classes. DOE's research indicated that shipment growth of 4-foot T5 miniature bipin SO lamps is primarily driven by a migration from the 4-foot medium bipin market. As this migration requires the purchase of a new fixture, to establish 4-foot miniature bipin T5 SO shipments, DOE allotted a portion of the 4-foot medium bipin fixture replacement, renovation, and new construction markets to 4-foot T5 miniature bipin systems. To do this, DOE first calculated the size of this potential market for new 4-foot T5 MiniBP SO systems in each year. DOE then determined the portion of this market that would actually be serviced by 4-foot T5 MiniBP SO lamps by calculating the share that resulted in T5 shipments consistent with 2006 and 2007 historical data. DOE held this resulting percentage—approximately 12.5 percent of the fixture replacement, renovation, and new construction market—constant throughout the analysis period.

DOE developed 4-foot T5 MiniBP HO lamp shipments by modeling a migration from two different lighting markets. Similar to 8-foot recessed double contact HO systems, marketing literature indicates a large portion of 4-foot MiniBP T5 HO systems serve high-bay applications due to their highly concentrated light output. Historical shipment data for 8-foot recessed double contact HO lamps shows substantial declines in 2006 and 2007, indicating T5 HO lamps may be rapidly displacing them. In addition, DOE's research indicated that a significant portion of 4-foot T5 MiniBP HO growth can be attributed to their penetration into the high intensity discharge (HID) lamp high-bay and low-bay markets. Therefore, to calculate the growth in 4-foot MiniBP T5 HO lamp shipments, DOE assumed that these systems were penetrating both the 8-foot recessed double contact HO and HID markets. Similar to its analysis for T5 SO systems, DOE established that the fixture replacement, renovation and new construction market segments represent the available market for 4-foot MiniBP T5 HO systems. DOE obtained HID shipment data from the HID determination, from which DOE calculated the total lumens servicing low bay and high bay applications. Then, consistent with historical 4-foot T5 MiniBP HO and 8-foot recessed double contact HO shipments, DOE assumed 4-foot T5 MiniBP HO lamps fully penetrate the 8-foot recessed double contact HO fixture replacement, renovation, and new construction market segments, as well as HID new construction and renovation market segments.

DOE bases its shipment estimates due to new construction based on EIA's AEO2008, which estimates year-to-year commercial floor space and residential building growth. Because the AEO2008 takes into account future trends in economic growth, DOE was able to incorporate forecasts of macroeconomic conditions in its growth forecasts. However, because the AEO does not provide industrial floor space forecasts, DOE used historical MECS floor space values to establish a growth rate for the industrial sector.

In addition to residential building growth, DOE also modeled a trend toward an increasing number of 4-foot medium bipin T8 and T12 lamps per home. DOE conducted an analysis to estimate the average number of T8 and T12 lamps in homes between 2005 and 2042. Using California data on these lamps, which was broken out by home age,[2] DOE assumed that the same number of T8 and T12 lamps per home would be installed in new homes as those installed between 2001 and 2005, and that half of homes built before 2001 would be renovated by 2042 to have the same number of T8 and T12 lamps as newly constructed homes. DOE estimated that the average number of T8 and T12 per lamps home in 2005 was 4.5, and the average number in 2042 will be 4.7. Combining this growth estimate of 4-foot medium bipin lamps per home with AEO2008's projected growth in the residential home stock yields an average growth rate of 1 percent between 2006 and 2042 for GSFL in the residential sector.

10.2.2 Incandescent Reflector Lamps

Similar to DOE's treatment of separate product classes based on CCT for GSFL, DOE forecasts IRL shipments by aggregating across all IRL product classes (standard-versus modified-spectrum, high-versus-low voltage, and high-versus-low diameter). In each of these cases of aggregation, DOE used a representative product class (standard-spectrum, low-voltage, high-diameter IRL) to evaluate lamp designs. DOE believes that the national impacts will be similar for other product classes not directly analyzed. By aggregating the product classes, DOE assumes that there will be no significant migration of shipments or stock between lamps in different product classes.

The IRL shipments model forecasts IRL socket growth in both the commercial and residential sectors, reflecting new construction in each sector. As with GSFL, DOE uses EIA's AEO2008 to project residential building stock growth and commercial floor space growth. Additionally, in the residential sector, DOE models a trend toward an increasing number of sockets per home. DOE conducted an analysis that estimated the average number of recessed cans in homes between 2005 and 2042. Using California data on recessed cans per home, broken out by home age[3], DOE assumed new homes constructed after 2005 would install the same number of recessed cans per home as homes constructed between 2001 and 2005. DOE also assumed that half of the homes constructed before 2001 would be renovated by 2042 to have an equal number of recessed cans per home as newly constructed homes. DOE estimated the distribution of homes by age using U.S. Census data on new building starts in the residential sector[4]. DOE estimated new construction and the number of future homes constructed in each year from EIA's AEO2008. Using this data, DOE estimated that the average number of recessed cans per home in 2005 was 4.82 and the average number of recessed cans in homes in 2042 would be 8.52. Finally, to estimate the socket growth rate in each year, DOE multiplied the number of recessed cans in homes by the projected stock of homes in each year according to EIA's AEO2008. Combining these two sources, DOE predicts an average growth rate of 2.6 percent between 2006 and 2042. The model ships lamps every year to replace retiring lamps and to meet growth in the stock of lamps. DOE models lamp designs based on three lumen packages in the commercial and residential sectors: 630, 1,050 and 1,310 lumens (lm). Consumers who purchase lamps with a particular lumen package in the base case generally purchase lamps with that same lumen package in the standards-case.

Similar to the GSFL shipments forecast, DOE establishes the timing of lamp replacements by tracking lamp shipments and then predicting when those lamps will retire based on their service lifetimes. As discussed in the LCC and PBP analysis (Chapter 8), DOE calculates the service lifetimes of lamps by dividing the lamp lifetime in hours by the annual operating hours. As discussed in the energy use characterization (Chapter 6), DOE uses five different operating hours to characterize the usage of incandescent reflector and reflector compact fluorescent lamps in the residential sector. By using different operating hours, DOE effectively varies the service lives of the modeled lamps, thereby affecting shipments.

10.3 BASE CASE INPUTS AND FORECASTS

This section does the following: 1) describes the two base case scenarios DOE employs in its analysis and the base case input market-share matrices for GSFL and IRL; 2) presents the base case forecasts for each lamp type along with historical lamp shipments data; and 3) presents base case forecasts for each lamp type with each lamp design and lamp-and-ballast design. The base case input market-share matrices correspond to the matrices introduced above in Section 10.2.

10.3.1 Base Case Scenarios Analyzed

DOE recognizes that rapidly emerging new lighting technologies could penetrate GSFL and IRL markets and significantly affect shipment forecasts. These technologies, such as reflector compact fluorescent lamps (R-CFL), ceramic metal-halide (CMH), and light-emitting diodes (LEDs), already are, or eventually will be, significantly more efficacious and longer lasting than the lamps they replace. If these emerging technologies achieve their potential, they may significantly affect the benefit calculations from efficiency standards. However, to calculate NES and NPV change do to emerging technologies, DOE would need to accurately forecast the anticipated price and performance points of each emerging technology—a difficult and highly speculative task. Because of this high degree of uncertainly, DOE chose to analyze two base case scenarios for both GSFL and IRL: 1) "Existing Technologies" and 2) "Emerging Technologies." DOE believes evaluating two base case scenarios will more completely and transparently characterize the uncertainty in estimating emerging technologies' market penetration and the consequent impact on NPV and NES. Incorporating emerging technologies in the base case does not affect the relative benefits of each TSL and prevents uncertain projections of market share, price, or performance from obscuring the benefits derived from more efficient GSFL and IRL alone.

The assumptions and methodology that drive these scenarios vary slightly between GSFL and IRL, and the details specific to each are described in section 10.3.2 and 10.3.3, respectively. In general, DOE calculated the market penetration of each of the analyzed emerging technologies in each year from 2006 through 2042, assessing each sector separately. DOE determined the market penetration of the technology option that achieved the highest level of penetration in each year in each sector. DOE then decreased the analyzed market size in each year in each sector by the amount that corresponded to the highest level of market penetration achieved by a technology. For example, in the Emerging Technologies base case scenario, DOE effectively reduced the 2042 IRL residential market size by 60 percent to reflect expected LED market penetration, which was the highest of all analyzed emerging technologies.

For its base case analysis, DOE estimated the market penetration of three specific technologies into the projected installed stock: LED lamps, CMH lamps, and reflector CFL. In general, the Existing Technologies scenario only considers the market penetration of technologies that have reached maturation in terms of price and efficacy. Specifically, R-CFL is the only technology that DOE considered in the Existing Technologies scenario, and only within the IRL market. For GSFL, no technologies outside those covered by this rulemaking were analyzed in the Existing Technologies scenario.

The Existing Technologies scenario assumes more limited penetration of other higher efficacy products than the Emerging Technologies scenario. Thus, the Existing Technologies scenario will yield greater NES than the Emerging Technologies scenario because the latter assumes a base case in which annual stocks comprise a greater level of higher efficacy products. Therefore, the efficacy differential between those products and those in the standards-case will be smaller than the differential between Existing Technologies (lower efficacy products) and the standards-case products.

In the Emerging Technologies scenario, DOE attempts to forecast the market penetration of both mature technologies <u>and</u> those technologies that are still undergoing significant changes in price and efficacy. Specifically, DOE considered the market penetration of R-CFL, LED lamps, and CMH lamps in the Emerging Technologies scenario.

DOE generally followed a 5-step process for each scenario to estimate the market penetration of the analyzed technologies and account for their impact on NES and NPV.

First, DOE developed price, performance, and efficacy forecasts for each of the analyzed technologies. Second, using those estimates, DOE calculated the payback period (PBP) of each technology in the relevant sector using the difference between its purchase price, annual electricity cost, and annual lamp replacement cost relative to the lamp it replaces. Specifically, DOE uses the following formula to calculate simple PBP:

$$SimplePayback = \frac{-\Delta Purchase\ \mathrm{Pr}ice\ (\$/klm)}{\Delta Annual\ Electricity\ Cost\ (\$/klm/yr) + \Delta Annual\ Lamp\ \mathrm{Re}placement\ Cost\ (\$/klm/y$$

Where:

- The Δ represents the difference between the two lamp options compared.
- Purchase Price includes the lamp price, and, in the case of the new and retrofit markets, the fixture price.

- Annual Electricity Cost is a function of the mean annual operating hours and efficacy for each lamp option, the electricity price, and the lumen demand.
- Annual Lamp Replacement Cost is a function of the mean lamp life, annual operating hours, and lamp price, as well as labor charge.

Third, DOE used the relationship between PBP and market penetration to predict the market penetration of each technology in the relevant sector in every year from 2006 to 2042. The relationship, which was used to estimate the penetration of solid-state lighting in a DOE report, predicts the market penetration based on the PBP of a technology. DOE assumed this relationship is valid for other emerging lighting technologies. That is, given a PBP of a certain duration, a technology can be expected to achieve a certain market penetration; the higher the PBP, the greater the expected market penetration. DOE used a 5-year average of the market penetrations predicted by the relationship as its final market penetration. The 5-year average represents the time DOE assumed it takes products with lower PBPs to penetrate the market.

Fourth, when necessary, DOE applied a scaling factor to the predicted market penetration to account for observed market trends. Fifth, as stated above, DOE reduced the projected installed stock of covered products in each year by the value that corresponded to the highest level of market penetration achieved in each year by one of the analyzed technologies. Thus, R-CFL and emerging technologies have the effect of lowering the energy savings of a potential new standard. For those covered lamps remaining, the cost effectiveness of LCC savings and thus the relative cost effectiveness of each TSL is not affected.

10.3.2 General Service Fluorescent Lamps

10.3.2.1 Base Case Scenarios

For the GSFL Existing Technologies scenario, DOE analyzes only the fluorescent technologies covered by the rulemaking because it believes that no mature technologies in the current market show the potential to significantly penetrate the GSFL market. (T5 lamps, a rapidly growing market, are considered in the analysis as covered products). In the GSFL Emerging Technologies scenario, however, DOE separately considered the potential market penetration of two technologies: 1) LED (into the commercial, residential, and industrial sectors), and 2) CMH (into the commercial and industrial sectors).

For its analysis of LED market penetration, DOE found a commercially available retrofit kit that included a LED replacement for a 4-foot medium bipin lamp-and-ballast system. DOE used the retrofit kit as a current baseline from which to project future cost, efficacy and price points. DOE interviewed an integrated circuit manufacturer to develop cost estimates for LED driver circuits. For cost estimates of other components, DOE used prices of existing LED products already on the market, which it modified in accordance with cost data and efficacy projections from DOE's Solid State Lighting Multi-Year Program Plan.[5] Lastly, after applying a markup based on currently available LED lamps, DOE arrived at price and efficacy projections for the LED luminaire in the retrofit kit[6]. For further detail on DOE's price and efficacy forecasts of potential LED replacements, see appendix 10C of the TSD. Following the 5-step process described above, DOE calculated a 41 percent market penetration rate of LED lamps into the 4-foot GSFL commercial sector by 2042. In the residential sector, the LED option did not have a low enough payback period to result in any market penetration. DOE assumed LED lamps penetrated only the new construction, renovation, and fixture replacement markets because these lamps would require their own specific fixtures.

DOE also analyzed the potential penetration of CMH into the GSFL market. DOE first estimated current CMH prices using a methodology similar to the methodology it used to estimate GSFL and IRL prices, as described in the product price determination. (See TSD chapter 4.) Industry experts informed DOE that CMH efficacies and lifetimes would increase over the next several years while prices would remain constant. Applying these lifetime and efficacy projections, DOE compared CMH replacements to GSFL systems. As a result, DOE assumed no market penetration CMH because it found that T5 lamp systems (standard output and high output) would always be more less costly and more efficacious than projected CMH replacements. Given this information, DOE believes that it is likely that migration to CMH (from the GSFL market) will be dominated by the migration to standard and high output T5 lamps.

10.3.2.2 Historical Shipments

As discussed in Chapter 3, DOE received 2001-to-2005 historical shipments from NEMA for 4-foot medium bipin, 8-foot single pin slimline, and 8-foot recessed double contact HO lamps. DOE also received confidential 2001-to-2005 shipments of 4-foot MiniBP T5 SO and HO lamps, and confidential shipment data for 2006 and 2007 for all lamp types. These shipments were broken down by lamp length, diameter, shape, and high output. Because DOE received confidential-only shipments for 4-foot T5 MiniBP SO and HO GSFL, DOE calculated historical shipments of these lamps based on the assumption that they represented 2 percent of the market in 2004, a figure that grew in 2005.[7] DOE assumed the T5 market is split evenly between standard output and high output. Recognizing that these shipment estimates reflect only the shipments of NEMA members, DOE increases these estimates to account for the volume of GSFL that non-NEMA lamp companies import or manufacture. DOE believes that these NEMA shipments represent about 90 percent of the GSFL market. Table 10.2 provides historical GSFL shipments estimates for the entire U.S. market.

Table 10.2 GSFL Total Historical Shipments (millions)

Year	4-foot T12 medium bipin	4-foot T8 medium bipin	8-foot T12 single pin slimline	8-foot T8 single pin slimline	8-foot T12 RDC HO	8-foot T8 RDC HO
2001	236.2	182.4	48.1	4.9	26.5	0.7
2002	228.9	181.8	46.0	5.9	27.1	0.6
2003	202.1	191.4	41.3	5.8	26.9	0.5
2004	195.4	217.4	40.3	6.4	27.3	0.7
2005	180.7	239.5	37.4	5.8	28.3	0,4

10.3.2.3 Calculation of Installed Stock in 2005

DOE calculates lamp and ballast stocks in 2005 of T8 and T12 4-foot medium bipin GSFL, 8-foot single pin slimline GSFL, and 8-foot recessed double contact HO using historical shipment data from NEMA. DOE calculates the 2005 lamp stock by summing backward from 2005 for the years that correspond to the service lifetime (i.e., the lifetime in hours divided by operating hours per year) of each lamp type. DOE disregards the 2005 stock of 8-foot T8 recessed double contact HO lamps in its analysis because the stock was relatively small.

As for the 4-foot T5 MiniBP SO and HO lamps, DOE did not receive public historical shipments data therefore followed slightly different methodology to calculate their installed 2005 stock. First, DOE first estimated 2001-to-2005 shipments based on assumptions derived from its market research and supported by manufacturer interviews. As discussed above, market literature indicated that 4-foot MiniBP T5 lamps represented 2 percent of the 2004 GSFL market, a figure DOE assumed for its analysis. DOE's research also indicated that the combined market share of 4-foot MiniBP T5 SO and HO lamps was growing as a percentage of the overall GSFL market. Additionally, manufacturers estimated in interviews that current 4-foot MiniBP T5 shipments are split evenly between standard output and high output lamps. Using these assumptions, DOE generated historical shipment estimates for 2001 to 2005. It used these shipments estimates to calculate the initial stock of 4-foot MiniBP SO and HO lamps in the same manner it does for all other GSFL product classes. DOE models 4-foot MiniBP T5 shipments to be half standard output and half high output. (However, due to differing lifetimes, this does not imply an equal installed stock for each product class.) Finally, DOE received confidential aggregated (both SO and HO) T5 lamp shipment data from NEMA for 2001 to 2007. DOE used this data to validate its installed stock estimates.

As it relates to the residential sector, DOE calculated the initial stock of 4-foot medium bipin T12 lamps using the lamps sold through the DIY distribution chain, which accounted for approximately 25 percent of NEMA's historical shipments. Next, DOE assumed 20 percent of those DIY sales went to small commercial consumers, with the remaining 80 percent apportioned to the residential sector. As a result, DOE assumed 20 percent of all 4-foot medium bipin shipments went to the residential sector and all of those were T12 lamps. From those shipments, DOE calculated the residential installed stock and then modeled new construction, renovation, and fixture/ballast replacement in the same manner described in section 10.2.1.

Using the 2005 lamp stocks, DOE calculated the installed ballast stocks by dividing the total stocks of lamps by the number of lamps per ballast system. Finally, to accurately forecast lamp and ballast shipments, DOE established a ballast age distribution for the installed ballast stocks using trends in ballast shipments, calibrated to shipment data for 2006 and 2007. Because historical shipments indicate that the 8-foot recessed double contact HO market is relatively flat, DOE uses a constant ballast age distribution for these ballast systems.

Based on manufacturer interviews, DOE assumes historical 4-foot T12 medium bipin, 8-foot T12 single pin slimline, and 8-foot T12 recessed double contact GSFL represent lamp shipments for installation on magnetic ballasts. DOE assumes that historical shipments of all other GSFL represented lamps shipped for installation on electronic ballasts. DOE establishes the corresponding ballast age distributions based on the decline in magnetic ballast shipments obtained from 2002 and 2005 U.S. Census Bureau data.[8,9] Table 10.3 provides lamp and ballast stocks in 2005 for all analyzed GSFL.

Table 10.3 2005 Lamp and Ballast Stocks (millions)

System Type	Sector	Lamp Stock	Ballast Stock	Ballasts in First Year of Service	Ballasts Halfway through Service Lifetime*	Ballasts in Last Year of Service
4-foot T8 MBP	Commercial	1,016.0	338.7	40.1	25.1	3.8
4-foot T12 MBP	Commercial	525.3	175.1	2.1	10.2	15.7
4-foot T12 MBP	Residential	1,333.4	666.7	44.4	44.4	44.4
8-foot T8 SP slimline	Commercial	21.9	11.0	0.7	0.7	0.8
8-foot T12 SP slimline	Commercial	125.0	62.5	1.8	3.8	7.0
8-foot T8 RDC HO	Industrial	60.2	30.1	2.9	2.9	2.9
8-foot T12 RDC HO	Industrial	0.0	0.0	0.0	0.0	0.0
4-foot T5 MiniBP SO	Commercial	28.1	14.1	2.3	1.1	0
4-foot T5 MiniBP HO	Industrial	19.7	9.9	1.9	1.1	0

* Fifth year of service for 8-foot recessed double contact HO and 4-foot T5 HO systems and seventh year of service for all other system types.

10.3.2.4 Base Case Market-Share Matrices

As discussed in the engineering analysis (Chapter 5) and the LCC and PBP analyses (Chapter 8), consumers have a variety of choices in lamp and lamp-and-ballast systems. When choosing lighting systems, consumers often make their choices considering lamp attributes such as lifetime, efficacy, price, lumen output, rated wattage, and total system power. As discussed earlier, the shipments for GSFL depend on such input assumptions as lamp lifetime and system lumen output. In addition, other lamp or lamp-and-ballast system properties such as price and energy consumption are key inputs to the NES and NPV calculations. Therefore, within each product class, DOE believes it is necessary to directly account for the mix of technologies that consumers select in the base case and standards-case. To account for the range of possible consumer choices, DOE develops and populates technology market-share matrices. These market-share matrices allocate percentage market shares to each lamp-and-ballast design for the base case and standards-case by proportioning shipments. As discussed in the NIA (Chapter 10), the base case and standards case efficacy forecasts also depend on the market-share matrices.

The GSFL shipments model incorporates several separate market-share matrices to characterize shipments of lamps and lamp-and-ballast systems at different times during the analysis period. Because the lamp design technology mix may change over time, DOE defines separate market-share matrices for systems purchased in 2012 and earlier and for systems purchased in 2042 for each analyzed system type (e.g., 4-foot T8 medium bipin). To determine the technology mix of the shipments for the intermediate years of the analysis period, DOE used a linear progression from 2012 to 2042. For each lamp type and market-share matrix, DOE generates the lamp-and-ballast designs by pairing each lamp design (as presented in Chapter 5) with commercially available ballasts that exhibit the most common ballast factors. This produces both energy-saving and non-energy-saving options.

Table 10.4 through Table 10.14 illustrate the base case market-share matrices for GSFL. DOE developed the percentage inputs to these matrices based on discussions with manufacturers and industry experts. In addition, DOE analyzed the quantities of commercially available products to develop the breakdown of percentage shipments by lamp efficacy. As Table 10.4, Table 10.8, Table 10.10, and Table 10.12 indicate, DOE assumes that in the base case, the technology mix of 4-foot T8 medium bipin (in the commercial sector only), 8-foot T8 single pin slimline, and 8-foot T12 recessed double contact HO lamp-and-ballast generally migrates to higher efficacy and lower ballast factors over the analysis period. DOE assumes the distribution of other lamp types remain constant over the analysis period.

Table 10.4 Base Case Market-Share Matrix for Four-Foot T8 Medium Bipin Systems in the Commercial Sector

		EL	Lamp Efficacy	Lamp Wattage	Lamp Lifetime	System Input Power	Installed Lamp Price	Mix of Systems Purchased in 2012 and Earlier	Mix of Systems Purchased in 2042
			*lm/W**	*W*	*hrs*	*W*	*$*	*%*	*%*
Electronic Ballast Factor	0.88	2	86.2	32.5	20,000	86.8	3.93	49%	20%
		3	90.8	32.5	20,000	86.8	4.96	25%	3%
		4	92.3	32.5	24,000	86.8	5.10	6%	0%
		4	93.8	30.0	20,000	80.4	5.39	1%	10%
		4	93.0	25.0	30,000	66.5	6.64	2%	15%
		5	95.4	32.5	24,000	86.8	5.63	4%	0%
		5	96.0	28.0	18,000	69.7	5.19	3%	18%
	0.78	2	86.2	32.5	20,000	77.9	3.93	0%	0%
		3	90.8	32.5	20,000	77.9	4.96	2%	0%
		4	92.3	32.5	24,000	77.9	5.10	2%	2%
		4	93.8	30.0	20,000	72.2	5.39	0%	0%
		4	93.0	25.0	30,000	59.4	6.64	1%	20%
		5	95.4	32.5	24,000	77.9	5.63	0%	0%
		5	96.0	28.0	18,000	67	5.19	0%	2%
	0.71	2	86.2	32.5	20,000	71.7	3.93	0%	0%
		3	90.8	32.5	20,000	71.7	4.96	2%	0%
		4	92.3	32.5	24,000	71.7	5.10	2%	0%
		4	93.8	30.0	20,000	66.4	5.39	0%	0%
		4	93.0	25.0	30,000	54.5	6.64	1%	10%
		5	95.4	32.5	24,000	71.7	5.63	0%	0%
		5	96.0	28.0	18,000	61.6	5.19	0%	0%
Total								**100**	**100**

* lm/W = lumens per watt

Table 10.5 Base Case Market-Share Matrix for Four-Foot T8 Medium Bipin Systems in the Residential Sector

		EL	Lamp Efficacy	Lamp Wattage	Lamp Lifetime	System Input Power	Installed Lamp Price	Mix of Systems Purchased in 2012 and Earlier	Mix of Systems Purchased in 2042
			*lm/W**	*W*	*hrs*	*W*	*$*	*%*	*%*
Electronic Ballast Factor	0.88	2	86.2	32.5	20,000	58.6	1.84	10	10%
		3	90.8	32.5	20,000	58.6	2.88	5	5%
		4	92.3	32.5	24,000	58.6	3.02	6	6%
		4	93.8	30.0	20,000	54.6	3.30	1	1%
		4	93.0	25.0	30,000	45.4	4.56	2	2%
		5	95.4	32.5	24,000	58.6	3.54	0	0%
		5	96.0	28.0	18,000	51.2	3.10	3	3%
	0.78	2	86.2	32.5	20,000	51.6	1.84	10	10%
		3	90.8	32.5	20,000	51.6	2.88	9	9%
		4	92.3	32.5	24,000	51.6	3.02	2	2%
		4	93.8	30.0	20,000	48.9	3.30	0	0%
		4	93.0	25.0	30,000	40.5	4.56	1	1%
		5	95.4	32.5	24,000	51.6	3.54	2	2%
		5	96.0	28.0	18,000	45.6	3.10	0	0%
	0.71	2	86.2	32.5	20,000	46.8	1.84	29	29%
		3	90.8	32.5	20,000	46.8	2.88	15	15%
		4	92.3	32.5	24,000	46.8	3.02	2	2%
		4	93.8	30.0	20,000	44.9	3.30	0	0%
		4	93.0	25.0	30,000	37.0	4.56	1	1%
		5	95.4	32.5	24,000	46.8	3.54	2	2%
		5	96.0	28.0	18,000	41.7	3.10	0	0%
							Total	**100**	**100**

Table 10.6 Base Case Market-Share Matrix for Four-Foot T12 Medium Bipin Systems in the Commercial Sector

	EL	Lamp Efficacy	Lamp Wattage	Lamp Lifetime	System Input Power	Installed Lamp Price	Mix of Systems Purchased before 2011*	Mix of Systems Purchased in 2042
		lm/W	*W*	*hrs*	*W*	*$*	*%*	*%*
Magnetic Ballast	0	78.0	40	20,000	107.7	4.60	0	0
	0	77.9	34	20,000	91.7	3.68	58	58
	1	80.5	40	20,000	107.7	6.80	20	20
	1	82.4	34	20,000	91.7	4.91	6	6
	1	82.9	40	24,000	107.7	8.35	8	8
	2	85.3	34	20,000	91.7	7.25	2	2
	2	87.8	40	24,000	107.7	8.45	5	5
	3	91.2	34	24,000	91.7	8.32	1	1
						Total	**100**	**100**

* In 2010, the sale of magnetic 4-foot T12 medium bipin ballasts is banned.

Table 10.7 Base Case Market-Share Matrix for Four-Foot T12 Medium Bipin Systems in the Residential Sector

<table>
<tr><th colspan="2" rowspan="2"></th><th>EL</th><th>Lamp Efficacy</th><th>Lamp Wattage</th><th>Lamp Lifetime</th><th>System Input Power</th><th>Installed Lamp Price</th><th>Mix of Systems Purchased in 2011 and Earlier</th><th>Mix of Systems Purchased in 2042</th></tr>
<tr><th></th><th>Lm/W</th><th>W</th><th>hrs</th><th>W</th><th>$</th><th>%</th><th>%</th></tr>
<tr><td rowspan="14">Electronic Ballast Factor</td><td rowspan="7">0.68</td><td>0</td><td>76.8</td><td>40</td><td>15,000</td><td>70</td><td>1.99</td><td>38</td><td>38</td></tr>
<tr><td>1</td><td>80.5</td><td>40</td><td>20,000</td><td>70</td><td>4.72</td><td>7</td><td>7</td></tr>
<tr><td>1</td><td>82.4</td><td>34</td><td>20,000</td><td>60</td><td>2.82</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>82.9</td><td>40</td><td>24,000</td><td>70</td><td>6.27</td><td>3</td><td>3</td></tr>
<tr><td>2</td><td>85.3</td><td>34</td><td>20,000</td><td>60</td><td>5.17</td><td>0</td><td>0</td></tr>
<tr><td>2</td><td>87.8</td><td>40</td><td>24,000</td><td>70</td><td>6.36</td><td>2</td><td>2</td></tr>
<tr><td>3</td><td>91.2</td><td>34</td><td>24,000</td><td>60</td><td>6.23</td><td>0</td><td>0</td></tr>
<tr><td>0.65</td><td>0</td><td>76.8</td><td>40</td><td>15,000</td><td>58</td><td>1.99</td><td>37</td><td>37</td></tr>
<tr><td>0.65</td><td>1</td><td>80.5</td><td>40</td><td>20,000</td><td>58</td><td>4.72</td><td>8</td><td>8</td></tr>
<tr><td>0.75</td><td>1</td><td>82.4</td><td>34</td><td>20,000</td><td>48</td><td>2.82</td><td>0</td><td>0</td></tr>
<tr><td>0.65</td><td>1</td><td>82.9</td><td>40</td><td>24,000</td><td>58</td><td>6.27</td><td>2</td><td>2</td></tr>
<tr><td>0.75</td><td>2</td><td>85.3</td><td>34</td><td>20,000</td><td>48</td><td>5.17</td><td>0</td><td>0</td></tr>
<tr><td>0.65</td><td>2</td><td>87.8</td><td>40</td><td>24,000</td><td>58</td><td>6.36</td><td>3</td><td>3</td></tr>
<tr><td>0.75</td><td>3</td><td>91.2</td><td>34</td><td>24,000</td><td>48</td><td>6.23</td><td>0</td><td>0</td></tr>
<tr><td colspan="8" align="right">Total</td><td>100</td><td>100</td></tr>
</table>

Table 10.8 Base Case Market-Share Matrix for Eight-Foot T8 Single Pin Slimline Systems

		EL	Lamp Efficacy	Lamp Wattage	Lamp Lifetime	System Input Power	Installed Lamp Price	Mix of Systems Purchased in 2012 and Earlier	Mix of Systems Purchased in 2042
			lm/W	*W*	*hrs*	*W*	*$*	*%*	*%*
Electronic Ballast Factor	0.88	3	94.8	60.1	15,000	112.8	$6.31	40	6
		4	98.2	60.1	15,000	112.8	$8.50	30	11
		5	101.5	60.1	18,000	112.8	$9.36	6	11
		5	101.8	57.0	24,000	107.5	$8.69	5	6
		5	103.6	55.0	18,000	102.0	$8.29	5	6
	0.85	3	94.8	60.1	15,000	109.1	$6.31	3	7
		4	98.2	60.1	15,000	109.1	$8.50	2	8
		5	101.5	60.1	18,000	109.1	$9.36	2	6
		5	101.8	57.0	24,000	106.0	$8.69	0	6
		5	103.6	55.0	18,000	98.5	$8.29	0	6
	0.78	3	94.8	60.1	15,000	100.4	$6.31	3	7
		4	98.2	60.1	15,000	100.4	$8.50	2	8
		5	101.5	60.1	18,000	100.4	$9.36	2	6
		5	101.8	57.0	24,000	102.5	$8.69	0	3
		5	103.6	55.0	18,000	90.2	$8.29	0	3
							Total	**100**	**100**

Table 10.9 Base Case Market-Share Matrix for Eight-Foot T12 Single Pin Slimline Systems

	EL	Lamp Efficacy	Lamp Wattage	Lamp Lifetime	System Input Power	Installed Lamp Price	Mix of Systems Purchased before 2011*	Mix of Systems Purchased in 2042
		lm/W	*W*	*hrs*	*W*	*$*	*%*	*%*
Magnetic Ballast	0	85.6	75.0	12,000	135	$8.02	46	46
	1	87.3	75.0	12,000	135	$11.21	16	16
	1	87.6	60.5	12,000	110	$5.60	15	15
	2	92.0	75.0	15,000	135	$12.16	1	1
	2	92.6	60.5	12,000	110	$7.94	15	15
	3	97.5	60.5	15,000	110	$9.66	7	7
						Total	**100**	**100**

* In 2010, the sale of magnetic 8-foot T12 single pin slimline ballasts is banned.

Table 10.10 Base Case Market-Share Matrix for Four-Foot T8 Medium Bipin Systems Replacing 8-foot T12 Single Pin Slimline Systems

		EL	Lamp Efficacy	Lamp Wattage	Lamp Lifetime	System Input Power	Installed Lamp Price	Mix of Systems Purchased in 2012	Mix of Systems Purchased in 2042
			lm/W	*W*	*hrs*	*W*	*$*	*%*	*%*
Electronic Ballast Factor	0.88	2	86.2	32.5	20,000	117.2	$4.91	49	20
		3	90.8	32.5	20,000	117.2	$5.94	25	3
		4	92.3	32.5	24,000	117.2	$6.08	6	0
		4	93.8	30.0	20,000	109.2	$6.37	1	10
		4	93.0	25.0	30,000	90.8	$7.62	2	15
		5	95.4	32.5	24,000	117.2	$6.61	4	0
		5	96.0	28.0	18,000	102.4	$6.17	3	18
	0.78	2	86.2	32.5	20,000	103.2	$4.91	0	0
		3	90.8	32.5	20,000	103.2	$5.94	2	0
		4	92.3	32.5	24,000	103.2	$6.08	2	2
		4	93.8	30.0	20,000	97.8	$6.37	0	0
		4	93.0	25.0	30,000	81.0	$7.62	1	20
		5	95.4	32.5	24,000	103.2	$6.61	0	0
		5	96.0	28.0	18,000	91.2	$6.17	0	2
	0.75	2	86.2	32.5	20,000	93.6	$4.91	0	0
		3	90.8	32.5	20,000	93.6	$5.94	2	0
		4	92.3	32.5	24,000	93.6	$6.08	2	0
		4	93.8	30.0	20,000	89.8	$6.37	0	0
		4	93.0	25.0	30,000	74.0	$7.62	1	10
		5	95.4	32.5	24,000	93.6	$6.61	0	0
		5	96.0	28.0	18,000	83.4	$6.17	0	0
							Total	**100**	**100**

Table 10.11 Base Case Market-Share Matrix for Eight-Foot T8 Recessed Double Contact High Output Initial and New Ballast Systems

		EL	Lamp Efficacy	Lamp Wattage	Lamp Lifetime	System Input Power	Installed Lamp Price	Mix of Systems Purchased in 2012 and Earlier	Mix of Systems Purchased in 2042
			lm/W	*W*	*hrs*	*W*	*$*	*%*	*%*
Electronic Ballast Factor	**0.88**	4	91.9	86	24,000	160.0	$9.92	10	10
		4	93.0	86	18,000	160.0	$10.09	45	45
		5	95.3	86	18,000	160.0	$11.53	45	45
	0.81	4	91.9	86	24,000	151.0	$9.92	0	0
		4	93.0	86	18,000	151.0	$10.09	0	0
		5	95.3	86	18,000	151.0	$11.53	0	0
							Total	**100**	**100**

Table 10.12 Base Case Market-Share Matrix for Eight-Foot T12 Recessed Double Contact High Output Initial and New Ballast Systems

		EL	Lamp Efficacy	Lamp Wattage	Lamp Lifetime	System Input Power	Installed Lamp Price	Mix of Systems Purchased in 2012 and Earlier	Mix of Systems Purchased in 2042
			lm/W	*W*	*hrs*	*W*	*$*	*%*	*%*
Electronic Ballast Factor	0.88	0	80.1	113	12,000	237.0	$9.79	20	5
		0	82.5	97	12,000	203.0	$6.88	7	3
		1	83.2	113	12,000	237.0	$15.56	11	13
		2	86.1	97	12,000	203.0	$9.95	3	11
		3	87.6	97	12,000	203.0	$16.11	6	12
		3	88.9	97	12,000	203.0	$16.42	3	6
	0.89	0	80.1	113	12,000	205.4	$9.79	10	2
		0	82.5	97	12,000	177.0	$6.88	4	2
		1	83.2	113	12,000	205.4	$15.56	5	6
		2	86.1	97	12,000	177.0	$9.95	2	5
		3	87.6	97	12,000	177.0	$16.11	3	7
		3	88.9	97	12,000	177.0	$16.42	2	4
	0.90	0	80.1	113	12,000	211.5	$9.79	9	2
		0	82.5	97	12,000	185.6	$6.88	4	1
		1	83.2	113	12,000	211.5	$15.56	5	6
		2	86.1	97	12,000	185.6	$9.95	2	5
		3	87.6	97	12,000	185.6	$16.11	3	6
		3	88.9	97	12,000	185.6	$16.42	1	4
							Total	**100**	**100**

Table 10.13 Base Case Market-Share Matrix for Four-Foot T5 Standard Output Initial and New Ballast Systems

		EL	Lamp Efficacy	Lamp Wattage	Lamp Lifetime	System Input Power	Installed Lamp Price	Mix of Systems Purchased in 2012 and Earlier	Mix of Systems Purchased in 2042
			lm/W	*W*	*hrs*	*W*	*$*	*%*	*%*
Electronic Ballast Factor	**1.15**	0	86.0	27.8	20,000	70.7	$4.69	14	14
		1	104.3	27.8	20,000	70.7	$6.58	19	19
		2	109.7	27.8	20,000	70.7	$7.68	5	5
		2	111.5	26	25,000	67.5	$7.43	3	3
	1.00	0	86.0	27.8	20,000	63.6	$4.69	7	7
		1	104.3	27.8	20,000	63.6	$6.58	18	18
		2	109.7	27.8	20,000	63.6	$7.68	5	5
		2	111.5	26.0	25,000	59.6	$7.43	3	3
	0.90	0	86.0	27.8	20,000	58.9	$4.69	0	0
		1	104.3	27.8	20,000	58.9	$6.58	18	18
		2	109.7	27.8	20,000	58.9	$7.68	5	5
		2	111.5	26.0	25,000	54.4	$7.43	3	3
							Total	**100**	**100**

Table 10.14 Base Case Market-Share Matrix for Four-Foot T5 High Output Initial and New Ballast Systems

		TSL	Lamp Efficacy	Lamp Wattage	Lamp Lifetime	System Input Power	Installed Lamp Price	Mix of Systems Purchased in 2012 and Earlier	Mix of Systems Purchased in 2042
			lm/W	*W*	*hrs*	*W*	*$*	*%*	*%*
Electronic Ballast Factor	**1.00**	0	76.0	53.8	20,000	120.0	$5.22	20	20
		1	92.9	53.8	20,000	120.0	$7.73	65	65
		1	98.0	51.0	25,000	117.0	$9.92	15	15
							Total	**100**	**100**

10.3.2.5 Base Case Forecast Results

Figure 10.3.1, Figure 10.3.2, Figure 10.3.3, and Figure 10.3.4 present the base case shipments forecasts from 2012 to 2042, modeled from the 2005 installed stock based on 2001-to-

2005 historical shipments. Figure 10.3.1, Figure 10.3.2, Figure 10.3.3, and Figure 10.3.4 correspond to 4-foot medium bipin shipments, 8-foot single pin slimline shipments, 8-foot recessed double contact HO shipments, and 4-foot T5 SO and HO, respectively. Each figure shows both the Existing Technologies and Emerging Technologies scenarios.

In accordance with historical shipment data, Figure 10.3.1 shows a decline over the analysis period in shipments of 4-foot T12 medium bipin lamps. These retired 4-foot T12 medium bipin lamp-and-ballast systems are replaced with 4-foot T8 medium bipin lamp-and-ballast systems upon ballast retirement. A decline in the commercial sector accounts for the majority of the reduction of the 4-foot T12 lamp shipments. As discussed earlier, DOE forecasts that 90 percent of retiring 3-lamp 4-foot T12 magnetic systems are replaced by one- and 2-lamp electronic 4-foot T8 systems, while 10 percent are replaced with the same 3-lamp T12 magnetic systems. DOE also forecasts that 80 percent of retired 8-foot T12 single pin slimline systems will be replaced with 4-foot T8 medium bipin lamp systems, which accounts for much of the increase in T8 systems. Along with the 4-foot T8 systems purchased to meet demand from the new construction, fixture replacement and renovation markets, this accounts for the increase in 4-foot T8 medium bipin shipments through the analysis period. Four-foot T12 systems remain present throughout the analysis period as they are shipped as replacements on magnetic ballasts in the residential sector. Additionally, 10 percent of retired 8-foot T12 single pin slimline systems will be replaced with electronic 4-foot T12 medium bipin systems in the commercial sector.

For 4-foot T8 lamps, the penetration of LED lamps in the base case is represented by the difference between the Emerging and Existing Technologies scenarios. As discussed previously, DOE's analysis showed no market penetration of LED lamps into the residential market. Furthermore, the available market for emerging technologies is composed of fixture replacement, renovation, and new construction. Because T12 lamps are only shipped in ballast replacement and lamp replacement events, there is no modeled impact of emerging technologies with regard to 4-foot T12 systems. Thus, 4-foot T12 shipments are equivalent in each base case scenario.

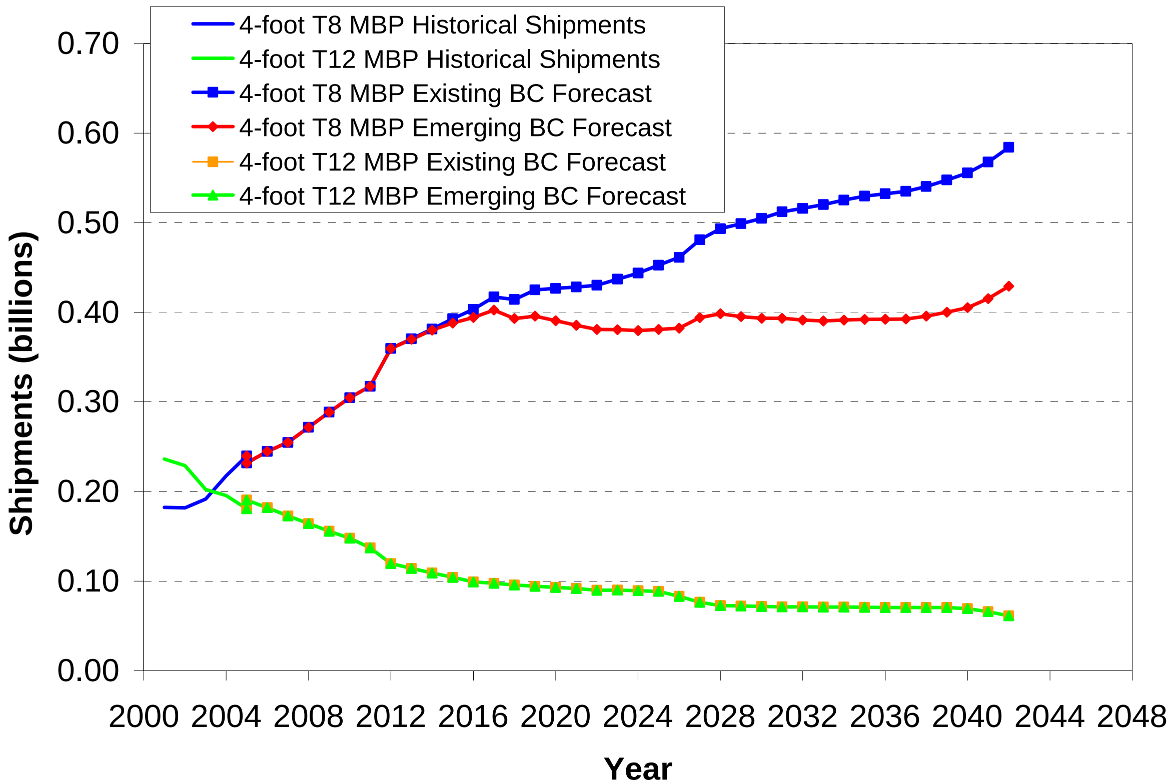

Figure 10.3.1 Four-Foot Medium Bipin Historical and Base Case Forecasted Shipments (Existing and Emerging Technologies Scenarios)
* MBP = medium bipin

In accordance with historical shipment data, Figure 10.3.2 shows a decline in shipments of 8-foot T12 single pin slimline lamps. Eighty percent of these retired 8-foot T12 single pin slimline lamp-and-ballast systems are replaced with 4-foot T8 medium bipin systems, which is reflected in the decline illustrated below. Of the remaining 20 percent of retiring systems, 10 percent are replaced by 8-foot T8 single pin slimline lamp-and-ballast systems upon ballast retirement while 10 percent remain 8-foot T12 systems. This accounts for the growth in 8-foot T8 single pin slimline lamp shipments until 2018, when a declining stock of retiring 8-foot single pin slimline T12 lamps no longer generates enough T8 replacements to maintain positive growth in T8 shipments. Eight-foot single pin slimline systems do not penetrate any of the new construction, renovation, and fixture replacement markets, which DOE assumes are serviced by 4-foot T8 medium bipin, 4-foot T5 standard output systems, and other emerging technologies, such as LED (in the Emerging Technologies scenario). Thus, the Emerging and Existing Technologies base cases are therefore equivalent for 8-foot single pin slimline lamps.

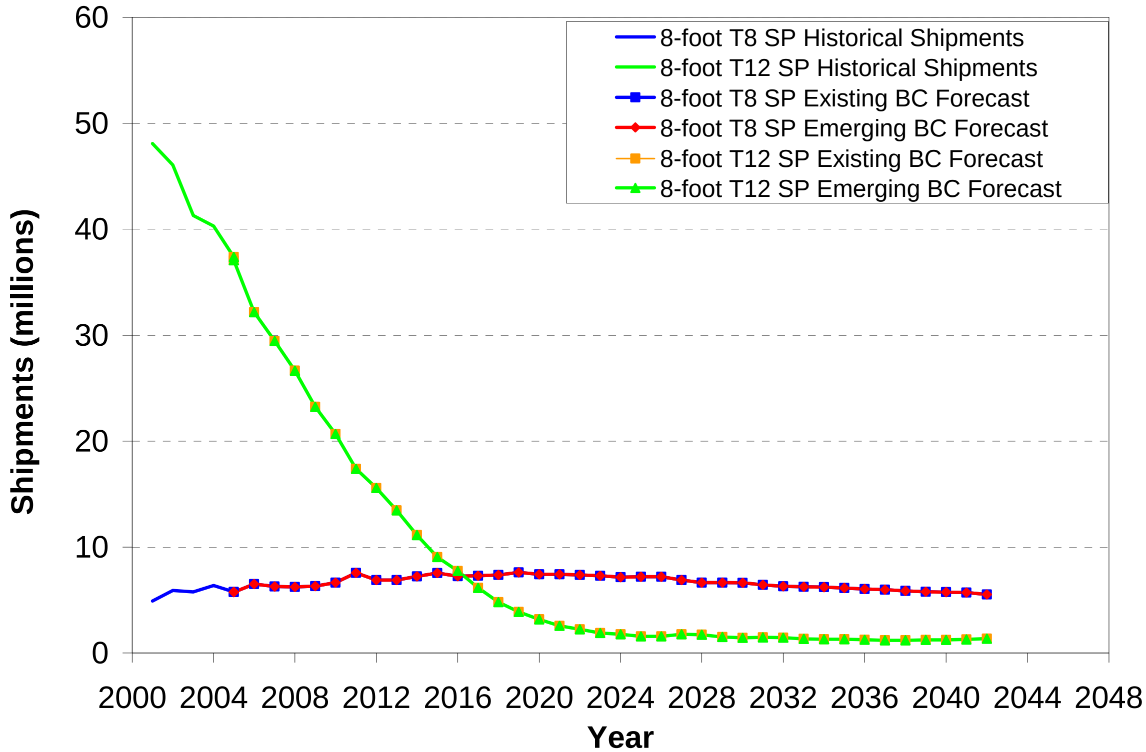

Figure 10.3.2 Eight-Foot Single Pin Slimline Historical and Base Case Forecasted Shipments (Existing and Emerging Technologies Scenarios)
* SP = single pin

Figure 10.3.3 shows that 8-foot T12 recessed double contact HO lamp shipments decline rapidly in the base case, which reflects a continuation of confidential shipments data. As discussed earlier, DOE decided not to model the 2011 stock of 8-foot T8 recessed double contact HO lamps, resulting in zero forecasted shipments in the base case. The decline is due to existing technologies that DOE believes are penetrating the fixture replacement, new construction, and renovation markets. DOE assumed most lighting systems purchased due to new construction are 4-foot T5 HO or other existing technologies such as HID. Therefore, the Emerging and Existing Technologies are the equivalent for the 8-foot recessed double contact high output product class.

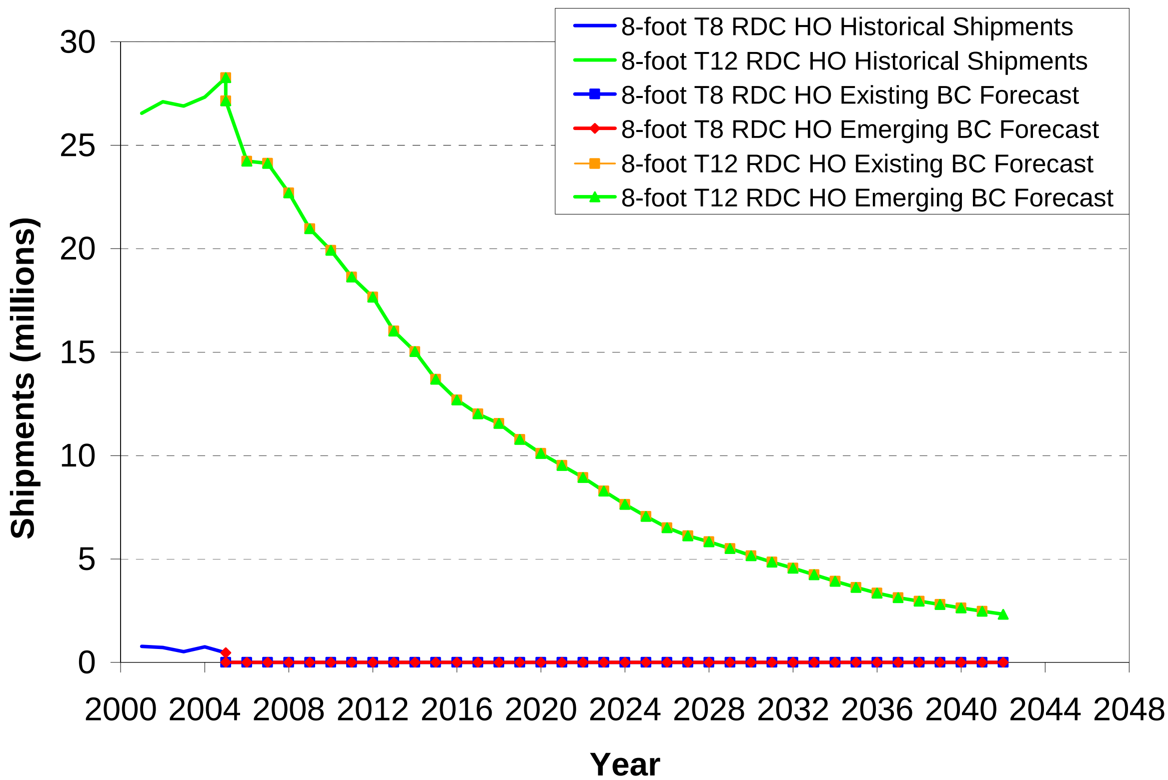

Figure 10.3.3 Eight-Foot Recessed Double Contact High Output Historical and Base Case Forecasted Shipments (Existing and Emerging Technologies Scenarios)
* RDC = recessed double contact, HO = high output

In accordance with confidential shipment data, Figure 10.3.4 depicts increasing shipments of 4-foot T5 standard output and high output lamps. DOE allotted a portion of the 4-foot MBP fixture replacement, renovation, and new construction markets to 4-foot T5 SO systems, driving the increase in SO shipments. Similarly, DOE assumed 4-foot T5 HO systems completely penetrate the 8-foot RDC HO market, which accounts for the former's increase over the analysis period. In the Existing Technologies scenario, four-foot T5 SO shipments slightly exceed those in the Emerging Technologies scenario because SO lamps are modeled to service new construction, fixture replacement, and renovation events which are being penetrated by LED lamps in the Emerging Technologies scenario. This yields a smaller stock of systems to migrate to 4-foot T5 SO lamps. For 4-foot T5 high output lamps, the Emerging and Existing Technologies scenarios are equivalent because DOE's analysis found that these lamps would always be more cost effective than CMH alternatives. Thus, there is no penetration of emerging technologies into the 4-foot T5 high output market. SO are coming from commercial new construction, fixture replacements, and renovation.

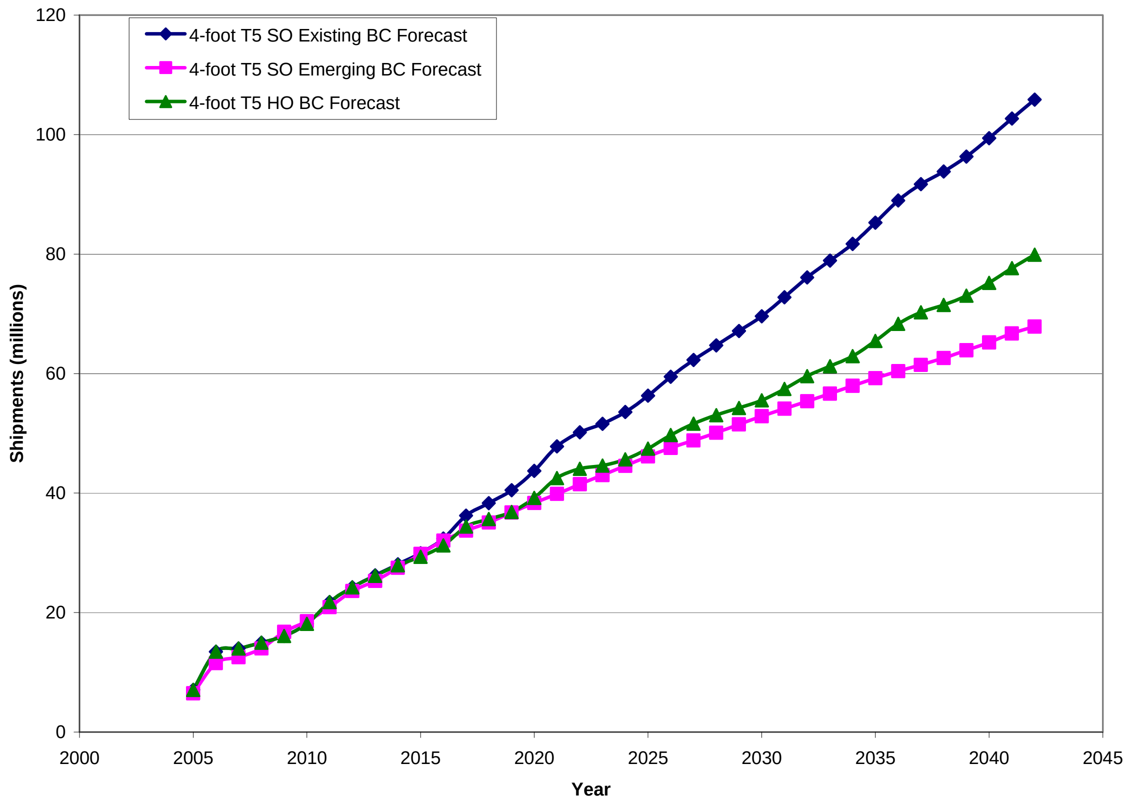

Figure 10.3.4 Four-Foot Standard Output and High Output Historical and Base Case Forecasted Shipments (Existing and Emerging Technologies Scenarios)

10.3.2.6 Base Case Forecast by Market Segment

Figure 10.3.5, Figure 10.3.6, Figure 10.3.7, and Figure 10.3.8 present the base case shipments forecast by market segment (i.e., lamp replacement, ballast replacement, or new construction) for 4-foot medium bipin, 8-foot single pin slimline, 8-foot recessed double contact HO, and 4-foot T5 SO and HO lamps, respectively. Figure 10.3.5 shows that although DOE accounts for shipments due to new construction, lamp shipments for replacing failed lamps and failed ballasts dominate this market. In addition, lamp replacement shipments are greater than ballast replacement shipments for all five product classes of GSFL. This effect is due to the much longer lifetime, and therefore fewer replacements, of ballasts relative to lamps.

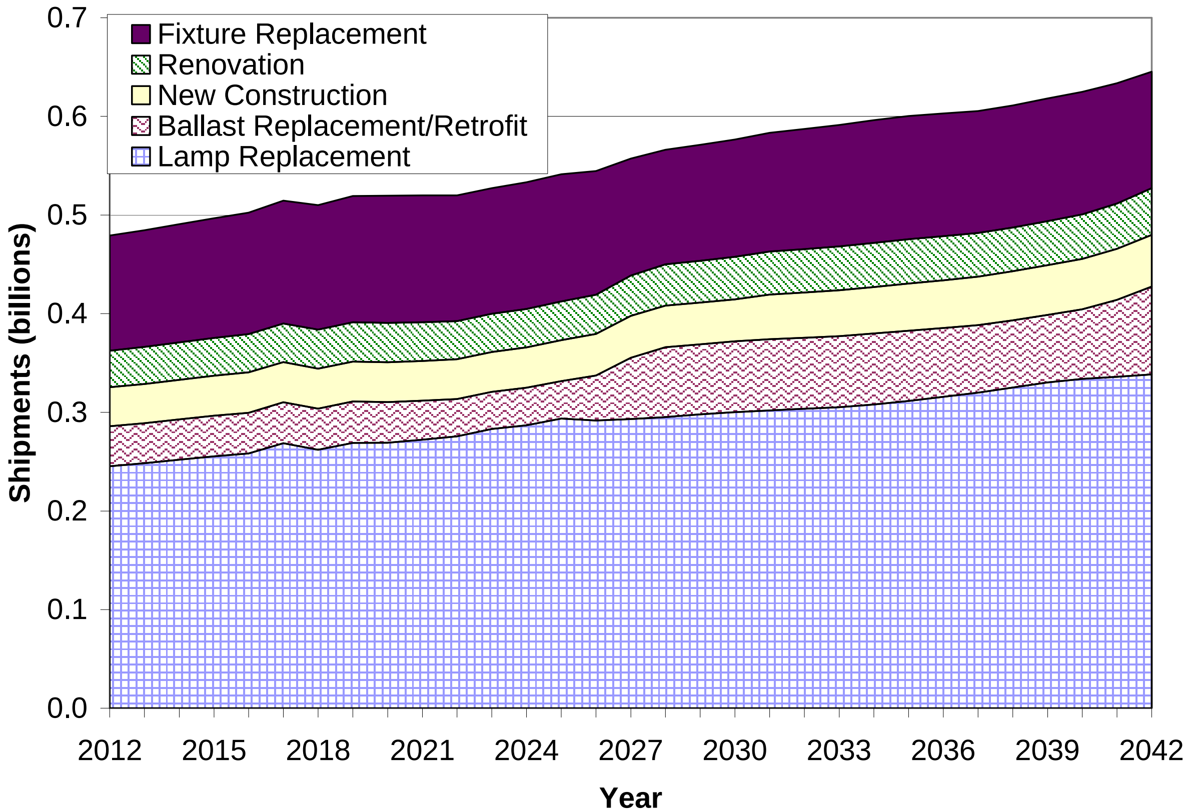

Figure 10.3.5 Four-Foot Medium Bipin Base Case Shipment Forecast by Market Segment

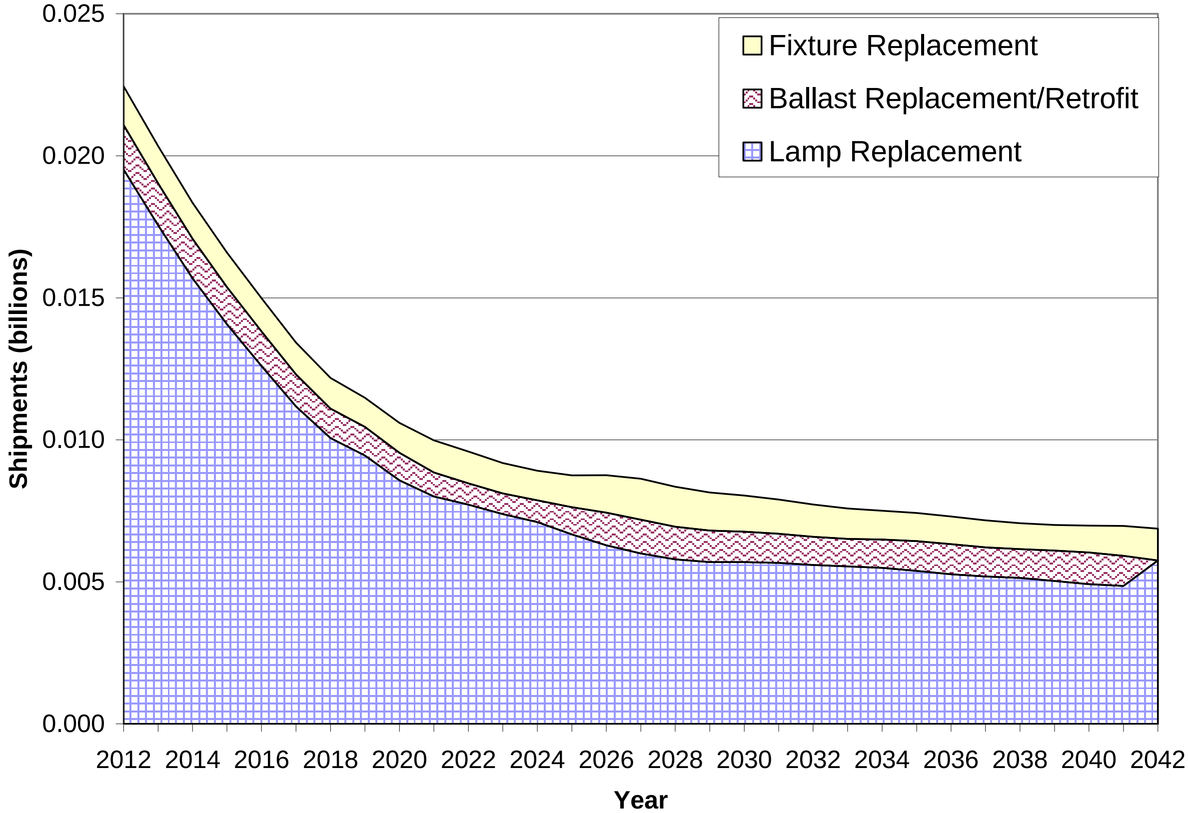

Figure 10.3.6 Eight-Foot Single Pin Slimline Base Case Shipments Forecast by Market Segment

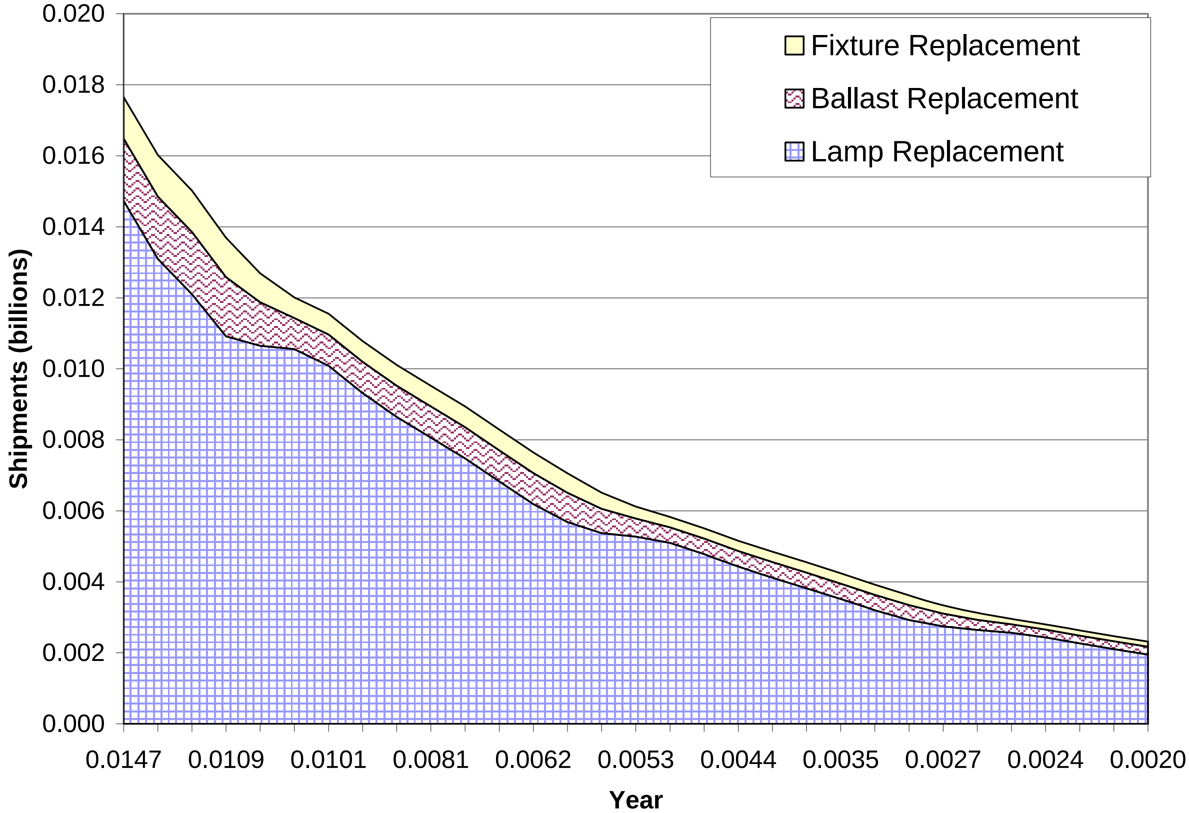

Figure 10.3.7 8-Foot Recessed Double Contact High Output Base Case Shipments Forecast by Market Segment

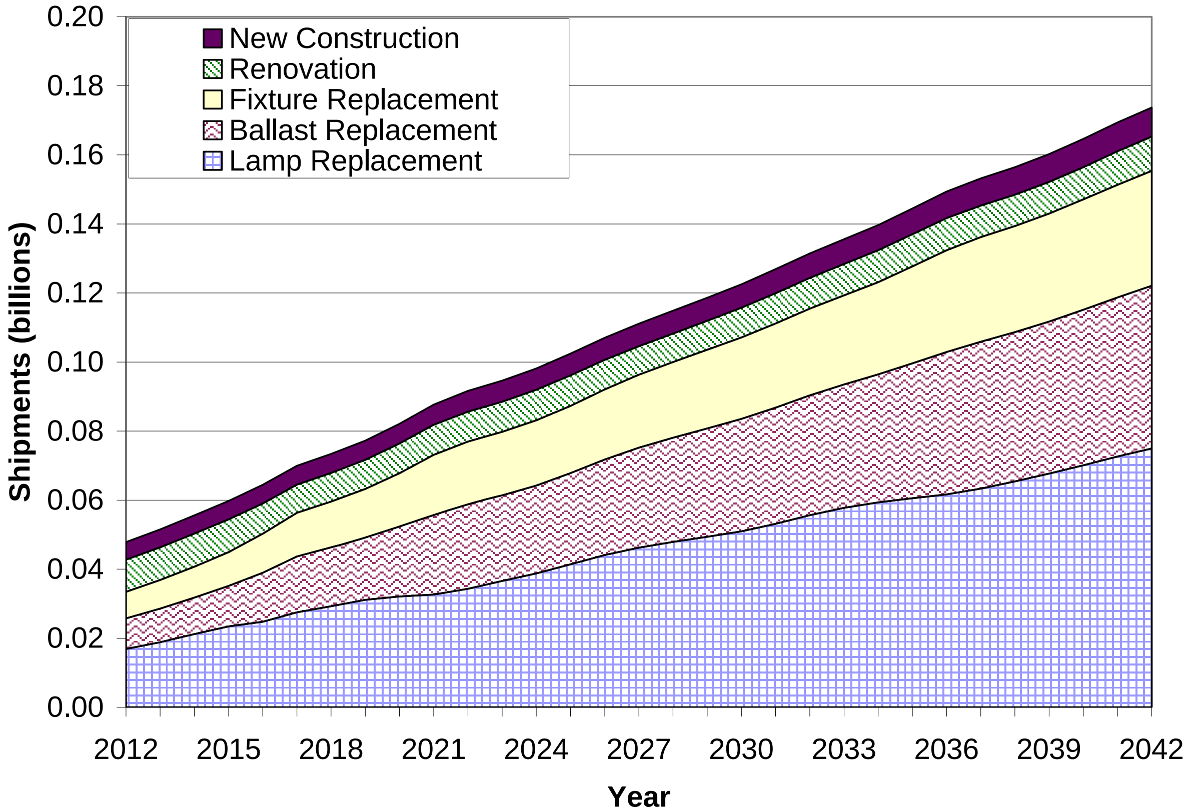

Figure 10.3.8 4-Foot T5 Standard and High Output Shipments Forecast by Market Segment

10.3.3 Incandescent Reflector Lamps

10.3.3.1 Base Case Scenarios Analyzed

As with GSFL, DOE considered two base case scenarios for IRL: Existing Technologies and Emerging Technologies. Because DOE believes that R-CFL are a mature technology with relatively stable price points and efficacies, DOE considered R-CFL penetration into the residential market in the Existing Technologies scenario. DOE did not consider migration to LED and CMH in the IRL Existing Technologies scenario. Therefore, the highest market penetration value (and reduction in market size) for the IRL Existing Technologies base case reflects R-CFL penetration in each year, as it is the only technology DOE analyzed.

In contrast, for the Emerging Technologies scenario DOE considered the market penetration of R-CFL, LED, and CMH lamps in both the residential and commercial sectors. DOE separately calculated the penetration of each technology into the IRL stock by using the 5-step process described above. The technology that achieves the maximum market penetration varies over the analysis period.

To model R-CFL penetration, DOE developed price forecasts based on historical pricing trends of CFL and R-CFL, using a methodology similar to the methodology DOE used to estimate GSFL and IRL prices, as described in the product price determination. (See TSD chapter 4.) DOE assumed no future change in efficacy. Using this data, DOE found the market penetration predicted by the PBP relationship. However, DOE believes that R-CFL may not always be appropriate in applications where IRL are used due to differences in color quality, size, dimming capability, and other factors. DOE observed that the actual market penetration of CFL replacements for A-line incandescent lamps thus far has been approximately 40 percent of the penetration predicted by the PBP-penetration relationship. Therefore, DOE applied these same scaling-factor reductions of 40 percent and 36 percent in calculating the market penetration of R-CFL into the IRL market for the residential and commercial sectors, respectively.

For LED and CMH lamps in IRL market, DOE developed price and efficacy forecasts using a methodology similar to the one described above for GSFL. Industry experts informed DOE that CMH efficacies and lifetimes would increase over the next several years while prices would remain constant. To develop LED lamp prices, DOE followed the same methodology it used in the GSFL-to-LED analysis. Using this information, DOE derived the necessary inputs to the PBP-penetration relationship for CMH and LED lamps. DOE did not apply the scaling factor reduction to the predicted LED and CMH market penetration rates that it used for the R-CFL analysis. DOE believes the substitutability problems that arise when R-CFL replace IRL do not apply when LED and CMH replace IRL.

By the methodology described, DOE arrived at market penetration values (and market size reductions) for each base case scenario. For the Existing Technology scenario, 2042 R-CFL penetration reached 38 percent in the residential sector and 20 percent in the commercial sector. (This was the highest market penetration because it was the only technology analyzed for the scenario.)

For the Emerging Technology scenario, LED reached the highest market penetration of any analyzed technology in both the residential sector and the commercial sector. DOE's analysis found LED lamps could penetrate 40 percent and 82 percent of the IRL installed stock by 2042 in the residential and commercial sector, respectively. DOE's results support a comment by Industrial Ecology stating that emerging technologies will enter the commercial market first. (Public Meeting Transcript, No. 21 at p. 308) This effect occurs because there are higher installation and operating costs in the commercial sector relative to the residential sector, resulting in lower PBPs and faster migration to emerging technologies. Again, DOE used these results to effectively reduce the size of the IRL market for its analysis.

10.3.3.2 Historical Shipments

As discussed in Chapter 3, DOE received historical shipments of IRL aggregated for the commercial and residential sectors from 2001 to 2005 from NEMA. NEMA broke these shipments down into parabolic reflector (PAR) incandescent, reflector (R) incandescent, PAR38 halogen, and PAR30 and PAR20 halogen lamps. Recognizing that these shipment estimates only reflect shipments of NEMA members, DOE increases these estimates to account for the volume of IRL that are imported or manufactured by non-NEMA lamp companies. DOE believes that these NEMA shipments represent approximately 85 percent of all halogen shipments and 70 percent of incandescent shipments.

Certain ER, BR, and R-shaped IRL (*e.g.,* BR 30 and BR40 65 Watt) are exempted from energy conservation standards. To account for these exemptions, DOE estimated the market share of these exemptions using a combination of manufacturer product catalog research and additional shipment data submitted by NEMA.[10] Because research indicated that these exemptions constitute approximately 60 percent of all incandescent (non-halogen) IRL shipments, DOE decreases the NEMA historical incandescent shipments and the base case installed stock accordingly.

In addition, because DOE's IRL shipment model separately forecasts IRL shipments in the commercial and residential sectors, DOE estimates certain portions of IRL shipments to each sector. DOE used a reflector lamp study conducted by the New York State Energy Research and Development Authority[11] to estimate that about 33 percent of non-halogen shipments serve the commercial sector and about 67 percent serve the residential sector. Similarly, DOE allocates 60 percent of halogen lamp shipments to the commercial sector and 40 percent to the residential sector.

Table 10.15 shows the resulting historical covered IRL shipments estimates for the entire U.S. market.

Table 10.15 IRL Historical Shipments (millions)

Year	Commercial	Residential
2001	70	72
2002	71	74
2003	74	77
2004	82	85
2005	87	94

10.3.3.3 Calculation of Installed Stock in 2005

To forecast IRL shipments from 2006 to 2042, DOE first estimates the IRL stock in 2005 using the above historical shipment data. DOE then forecasts IRL shipments from 2006 to 2042 by applying growth, replacement rate, and emerging technologies assumptions. The growth rate methodology and assumptions that DOE use are described in section 10.210.2.2. The average lifetime of halogen lamps and, therefore, the replacement rates, derive from the assumed base case technology mix of IRL in the commercial and residential sectors, which is reflected in the market-share matrices in section 10.3.3.4. DOE assumed incandescent IRL have a lifetime of 2,000 hours, as this is the most common incandescent lifetime on the market today. With this inputs, DOE calculated that the 2005 stock of covered IRL is approximately 224 million lamps in the residential sector and 64 million lamps in the commercial sector.

10.3.3.4 Base Case Market-Share Matrices

As discussed in the engineering analysis (Chapter 5) and the LCC analysis (Chapter 8), consumers have a variety of choices in IRL. IRL shipments strongly depend on lamp lifetime. In addition, other lamp properties such as price and energy consumption are key inputs to the NES and NPV calculations. Therefore, within IRL in the commercial and residential sectors, DOE believes it is necessary to directly account for the mix of technologies that consumers select in the base case and standards-case. To account for the range of possible consumer choices, DOE develops and populates technology market-share matrices. As discussed in the national impact analysis (NIA; Chapter 10), the base case and standards case efficacy forecasts also depend on the market-share matrices.

The IRL base case market-share matrices apportion the installed lamp stock in 2011 and 2042 by percentage market shares of each IRL lamp design. Given these two inputs, DOE creates a dynamic base case and assumes that the percentage stock values change linearly through the analysis period. Once DOE establishes the percentage stock in each year, DOE's model then ships lamps to maintain the stock distribution, taking into account lamp replacements and new construction.

DOE develops the percentage inputs to the base case market-share matrices based on discussions with industry experts and an examination of manufacturer product catalogs. As stated earlier, DOE models three separate lumen packages in the commercial and residential sectors: 630 lm, 1,050 lm and 1,310 lm. These lumen packages correspond to the 50W, 75W, and 90W baseline halogen technologies, respectively. An examination of manufacturer product catalogs indicates that 27 percent of the covered IRL market is at 630 lm, 32 percent is at 1,050 lm, and 41 percent is at 1,310 lm. DOE applies these percentages to the 2011 inputs to the base case market-share matrices for the commercial and residential sectors.

In addition, based on manufacturer interviews, in the commercial sector DOE assumes that 80 percent of the 2011 installed IRL stock is based on halogen technology, while 20 percent of installed IRL is of the more efficacious halogen infrared (HIR) technology. Because DOE expects a natural migration toward more efficacious IRL, DOE assumes that the installed IRL stock in the commercial sector in 2042 is 50 percent halogen and 50 percent halogen infrared. In contrast, in residential base case DOE assumes that 100 percent of installed IRL is halogen technology in 2011 and remains constant throughout the analysis period.

Table 10.16 and Table 10.17 provide the base case market-share matrices for IRL in the commercial and residential sectors.

Table 10.16 Base Case Market-Share Matrix for Commercial IRL Sockets

Trial Standard Level	Lamp Design	Installed Lamp Price	Stock in 2011 %	Stock in 2042 %
Base Case	90W, 14.6 lm/W, 2,500 hrs, Halogen	6.20	32	19
	75W, 14.0 lm/W, 2,500 hrs, Halogen	6.20	25	15
	50W, 12.6 lm/W, 3000 hrs, Halogen	5.59	21	12
	82.5W, 15.9 lm/W, 6,000 hours, Long Life HIR	7.76	2	5
	68.8W, 15.3 lm/W, 6,000 hours, Long Life HIR	7.58	2	4
	46W, 13.5 lm/W, 6,000 hours, Long Life HIR	7.15	1	3
	79W, 16.6 lm/W, 3,000 hurs, Imp. Halogen	7.58	1	2
	66W, 15.9 lm/W, 3,000 hours, Imp. Halogen	7.58	1	2
	45W, 14.0 lm/W, 3,000 hours, Imp. Halogen	6.98	1	1
	70W, 18.0 lm/W, 3,000 hrs, HIR	7.76	4	10
	60W, 17.5 lm/W, 3,000 hrs, HIR	7.76	3	8
	42W, 15.1 lm/W, 3000 hrs, HIR	7.15	3	7
	66W, 19.8 lm/W, 4,000 hurs, Imp. HIR	9.08	2	5
	55W, 19.1 lm/W, 4,000 hours, Imp. HIR	9.08	2	4
	40W, 17.0 lm/W, 4,000 hurs, Imp. HIR	8.47	1	3
	Total		**100**	**100**

Table 10.17 Base Case Market-Share Matrix for Residential IRL Sockets

Trial Standard Level	Lamp Design	Installed Lamp Price	Stock in 2011 %	Stock in 2042 %
Base Case	90W, 14.6 lm/W, 2,500 hrs, Halogen	5.13	41	41
	75W, 14.0 lm/W, 2,500 hrs, Halogen	5.13	32	32
	50W, 12.6 lm/W, 3000 hrs, Halogen	4.53	27	27
	Total		**100**	**100**

10.3.3.5 Base Case Forecast Results

Figure 10.3.9 depicts the base case shipment forecasts for all sectors of IRL from 2006 to 2042, and shows historical shipments from 2001 to 2005. The forecasted shipments in the Existing Technologies scenario essentially increase throughout the analysis period, reflecting both building and floor space growth and the trend toward more IRL per new home. These effects are offset, most noticeably from 2005 to 2012, by continued growth and market penetration of CFL, albeit at declining rates. DOE believes the historical growth rate of the IRL stock (approximately 8 to 10 percent annually—much higher than AEO2008's predicted building and floor space growth) is unsustainable. Confidential NEMA shipment data from 2006 and 2007, which show significant declines from 2005, support this assumption, Therefore, DOE bases IRL socket growth after 2005 on the AEO 2008 projected growth rate in building floor space, combined with the assumption that new-home construction and existing-home renovations in the residential sector will contain an increasing number of sockets per home (see section 10.2.2).

The Emerging Technologies scenario results in a similar but more pronounced pattern of declining shipments followed by gradually increasing shipments, as this scenario accounts for LED and CMH penetration in addition to CFLs. The continued introduction of additional CFLs and other long-lived emerging technologies into the market mitigates replacement needs initially as well, contributing to the forecasted decline in shipments.

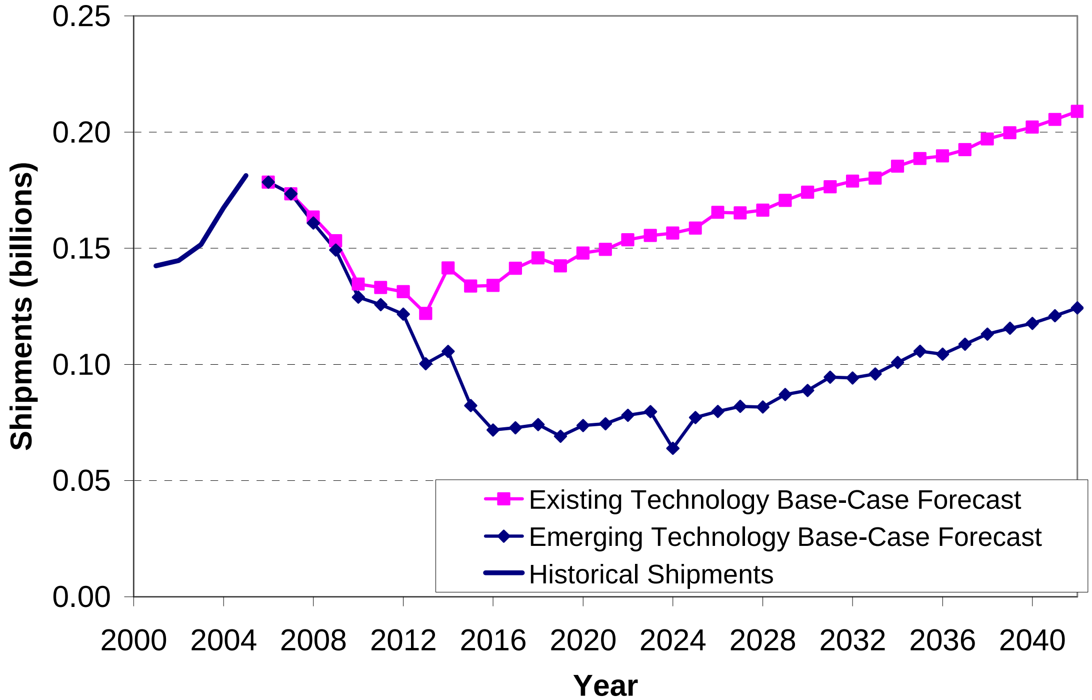

Figure 10.3.9 IRL Historical and Base Case Forecasted Shipments

10.3.3.6 Base Case Forecast by Market Segment

Figure 10.3.10 depicts the Emerging Technologies base case shipments forecast by market segment for IRL sockets for all sectors. As seen in the figure, DOE accounts for both lamp replacements and new construction. However, lamp shipments to replace failed lamps dominate this market.

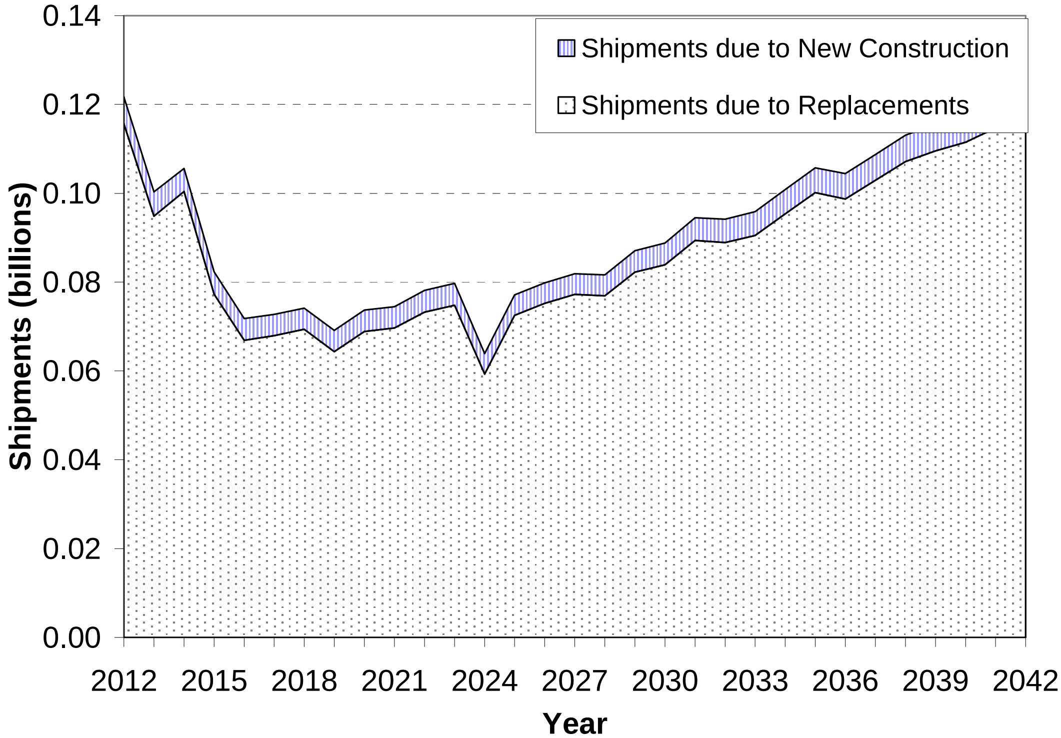

Figure 10.3.10 IRL Base Case Shipments Forecast by Market Segment (Emerging Technologies Scenario)

10.4 STANDARDS CASE INPUTS

10.4.1 General Service Fluorescent Lamps

10.4.1.1 Shipments Scenarios

To characterize consumer behavior in the standards-case, DOE considers many lamp-and-ballast system properties that consumers take into account when purchasing their GSFL systems. Specifically, DOE regards system price, system energy consumption, and system lumen output as three key drivers of consumer purchases.

DOE develops two sets of two shipments scenarios, or four standards-case scenarios in all, to characterize consumers that may weigh these factors differently. The first set of scenarios comprises the “Roll-up” and “Shift” scenarios; the second set comprises the “High” and “Market segment-based” lighting expertise scenarios. (Each scenario is detailed below.) To evaluate a standards-case, DOE models a standards-case scenario and compares it to the base case. One standards-case scenario, for example, would be the Roll-up, High lighting expertise scenario; another would be the Shift, Market Segment-Based expertise scenario. DOE thus considers four standards-case scenarios and two base case scenarios, yielding eight total sets of results.

The first set of standards-case scenarios for GSFL includes the "Roll-up" and "Shift" scenarios. The Roll-up scenario represents a standards-case in which all product efficacies in the base case that do not meet the standard would roll up to meet the new standard level. Consumers who in the base case purchase lamps above the standard level are not affected as they are assumed to continue to purchase the same base case lamp or lamp system in the Roll-up scenario. The Roll-up scenario characterizes consumers primarily driven by the first-cost of the lamp. In contrast, the Shift scenario models a standards-case in which *all* base case consumer purchases are affected by the standard (whether or not their base case efficacy is below the standard). In this scenario, any consumer may purchase a reduced-wattage lamp. As the standard level increases, market share incrementally accumulates at TSL5 because it represents "max tech" (i.e., moving beyond it is impossible). The Shift scenario characterizes consumers primarily concerned with system energy consumption, and reflects an upper bound scenario.

The following discussion presents the standards-case decision-making process characterized by the Roll-up scenario. Lamp-and-ballast designs from which consumers choose are presented in the market-share matrices.

1) If consumers buy a system in the base case that complies with the standard, then they buy the base case system.
2) If consumers do not buy a standards-compliant system in the base case, then they
    a. consider only systems that have a lumen output that is within 10 percent of the base case lumen output;
    b. select the lowest first-cost lamp-and-ballast design; or
    c. if there are two lamp-and-ballast designs with equal installed prices, they select the one with a lumen output that is closest to the base case lumen output.

The following discussion presents the standards-case decision-making process characterized by the Shift scenario.

1) If consumers buy the least efficacious lamp-and-ballast design in the base case, they then
    a. consider only systems that have a lumen output that is within 10 percent of the base lumen output;
    b. select the lowest first-cost lamp-and-ballast design; or
    c. if there are two lamp-and-ballast designs with equal installed prices, they select the one with a lumen output that is closest to the base case lumen output.
2) If consumers do not buy the least efficacious lamp-and-ballast design in the base case, they then
    a. never buy a system that has a greater input power than the base case system;
    b. consider only systems that have a lumen output within 10 percent of the base case lumen output. If none exist, buy the base case system (if it is standards-compliant);
    c. consider only systems that use less input power than the base case system. If none exist, they buy the lowest first-cost (if two lamp-and-ballast designs have equal installed prices, select the one with a lumen output that is closest to the base case lumen output);

d. select the lowest first-cost lamp-and-ballast design; or
e. if there are two lamp-and-ballast designs with equal installed prices, select the one with a lumen output that is closest to the base case lumen output.
f. in general consumers seek to shift to an efficacy level that keeps their purchase the same number of efficacy levels above the baseline as in the base case.

The second set of standards-case GSFL scenarios comprises the lighting expertise scenarios: High and Market Segment-Based. This set of scenarios characterizes consumers' decisions (or lack thereof) to either maintain equivalent light output upon the purchase of a new higher efficacy lamp or accept higher lighting levels. The High expertise scenario generally characterizes more sophisticated lighting decisions in which consistent lighting levels and/or energy savings play a determinant role in consumer behavior. In this scenario, consumers are more likely to choose a lower ballast factor to pair with higher efficacy lamps or reduced-wattage lamps. These consumers therefore generally save energy sure to standards. Conversely, in the Market Segment-Based scenario, DOE assumes consumers occasionally accept high lighting levels as a consequence of their expertise (or lack thereof). These consumers often seek to purchase the same wattage lamp (with higher efficacy) and same ballast factor as in the base case, thus often not saving energy as a result of standards. That expertise, and whether consumers migrate to lower ballast factors, is based on the consumer type (owner, electrical contractor, homebuilder, etc.) and the purchase event (new construction, replacement, etc.). DOE undertook an extensive literature review and analysis to characterize the likelihood of consumers migrating to lower ballast factor systems or reduce-wattage lamps if higher efficacy standards are required. The results characterize the Market Segment-Based scenario. DOE's analysis is described briefly below and in detail in Appendix 9A.

For its analysis, DOE first characterized the lighting market supply chain in the commercial and residential sectors and identified the decision makers within each one (e.g., contractors, homeowners, etc.). DOE broke down each sector by the principal events that prompt lamp purchases: ballast failure, retrofit, fixture replacement, renovation, and new construction. DOE assigned probabilities reflecting each decision maker's likelihood of making the lighting purchase decision given the purchase event. DOE then analyzed the likelihood of each decision maker choosing to run a lamp on a lower BF ballast if forced by standards to purchase a more efficacious lamp. DOE described that likelihood with a probability that was based on the technical expertise and motivation of the decision maker. Within each purchase event, DOE multiplied the likelihood of each market actor making the decision by the likelihood of that actor choosing a lower ballast factor ballast. In this way, DOE derived an estimate for the likelihood of a lower ballast factor being selected for each event in each sector in the standards-case.

DOE assumed the commercial and industrial sectors behave similarly with respect to ballast factor choices and no distinction was made between them in this analysis. Additionally, decision makers in the large-commercial sector can be different agents making different decisions than those in the small-commercial sector. In the market segments (purchase events) where DOE found consumer behavior to be substantially different between these subsectors, DOE weighted the relative impact of each subsector when characterizing the overall commercial market.   Table 10.18 and Table 10.19 present results for the commercial sector and residential sector, respectively.

Table 10.18 Commercial Market Segment-Based Likelihood of High Lighting Expertise

Lamp Purchase Event	Probability
Renovation	69%
New Construction	78%
Retrofit	92%
Ballast Replacement	8%
Fixture Replacement	34%

Table 10.19 Residential Market Segment-Based Likelihood of High Lighting Expertise

Lamp Purchase Event	Probability
Renovation	48%
New Construction	61%
Retrofit	0%
Ballast Replacement	0%
Fixture Replacement	0%

10.4.1.2 Standards-Case Market-Share Matrices

Similar to in the base case, DOE is constructing market-share matrices to characterize shipments of lamps and lamp-and-ballast systems in the standards-case. These market-share matrices provide the same lamp-and-ballast designs as the base case market-share matrices. However, in the standards-case, some lamp designs (and therefore lamp-and-ballast designs) are not standards-compliant and therefore precluded from being shipped. In addition, in the standards-case, the shipments model defines separate market-share matrices for the ballasts installed before 2012 (initial ballasts) versus new ballasts installed after 2011. This is important in the standards-case since consumer purchase decisions may vary in these two situations. If a consumer with an existing installed ballast in 2012 is forced to replace a base case lamp with a different standards-compliant lamp, the consumer is limited to only those lamp-and-ballast designs that maintain the current ballast. However, when a consumer purchases a new lamp-and-ballast system, either for retrofitting, ballast replacement, or new construction, all lamp-and-ballast systems, including those with ballast factors different from the base case system purchase, are available. Table 10.20 describes the inputs to the base case and standards-case market-share matrices for initial and new ballasts.

Table 10.20 Description of Base Case and Standards-Case GSFL Market-Share Matrices, Initial and New Ballast Models

Case	Initial Ballast Matrix (ballasts installed before 2012)	New Ballast Matrix (ballasts installed in 2012 and later)
Base	*#Technology mix of the lamp and ballast purchases before 2012	*Technology mix of new lamp-and-ballast systems purchased in 2012 and 2042
Standards	**#Technology mix of first-lamp purchases shipped for installation on ballasts purchased before 2012.	*Technology mix of new lamp-and-ballast systems purchased in 2012 and 2042

* Lamp replacement purchases are always the same lamp design as the retiring lamp.
** With the exception of the first lamp purchase after 2011, lamp replacement purchases are always the same as the retiring lamp.
# Though they are presented as lamp-and-ballast designs, during the analysis period these matrices result in shipments of lamps for lamp replacement purposes only.

DOE uses the Shift and Roll-up scenarios to populate the standards-case market-share matrices. Table 10.21 through Table 10.54 present the standards-case market-share matrices for all analyzed GSFL in both the Shift and Roll-up scenario. As seen in the standards-case market-share matrices for initial ballast systems, the base case proportions of lamp-and-ballast systems at each ballast factor are equivalent to the standards-case proportions. This is because these "initial ballast" standards-case matrices represent only lamp replacements on previously existing ballasts. In these situations, consumers are limited in their lamp-and-ballast designs and therefore may not always be able to match the lumens of their base case system.

As seen in the standards-case market-share matrices for "new ballasts," the distribution among ballast factors in the standards case shows a clear migration to lower ballast factors. By using a lower ballast factor with a higher efficacy lamp, consumers are better able to match the lumens of their lamp-and-ballast purchases with the lumens of their base case purchase.

The second set of standards-case scenarios, High-versus-Market Segment-Based scenario, also influences these market share matrices. Table 10.21 through Table 10.54 depict the High lighting expertise scenario. Under the High lighting expertise scenario, 100 percent of consumers can either shift or roll-up based on the factors they consider (energy savings, first cost, etc.) in making their purchase. These consumers with high lighting expertise will attempt to maintain lumen output by moving to a lower ballast factor if necessary. However, under the Market Segment-Based scenario, a certain percentage, based on the market segment, will only roll-up and will not move to lower ballast factors or reduced-wattage lamps to maintain lumen output. DOE created market share matrices to characterize these consumers. As an example, Table 10.27 presents the 4-foot T8 medium bipin new ballast market share matrix for those consumers characterized by low lighting expertise. Again, the selection of Shift or Roll-up has no affect on these consumers—they only roll-up in the standards-case.

Table 10.21 Standards-Case Initial Ballast Market-Share Matrix for Four-Foot T8 Medium Bipin Systems (Shift Scenario)

Mix of New Lamps Purchased as Replacements on Ballasts Installed before 2011 at Various Trial Standard Levels													
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case	TSL1	TSL2	TSL3	TSL4	TSL5
			Lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	2	86.2	32.5	6,653	86.8	3.93	49	49	49	0	0	0
		3	90.8	32.5	7,154	86.8	4.96	25	25	25	49	0	0
		4	92.3	32.5	7,524	86.8	5.10	6	6	6	6	6	0
		4	93.8	30.0	7,075	80.4	5.39	1	1	1	25	0	0
		4	93.0	25.0	6,204	66.5	6.64	2	2	2	2	2	0
		5	95.4	32.5	7,696	86.8	5.63	4	4	4	4	4	10
		5	96.0	28.0	6,758	69.7	5.19	3	3	3	4	78	80
	0.78	2	86.2	32.5	5,897	77.9	3.93	0	0	0	0	0	0
		3	90.8	32.5	6,341	77.9	4.96	2	2	2	0	0	0
		4	92.3	32.5	6,669	77.9	5.10	2	2	2	2	2	0
		4	93.8	30.0	6,271	72.2	5.39	0	0	0	2	0	0
		4	93.0	25.0	5,499	59.4	6.64	1	1	1	1	1	0
		5	95.4	32.5	6,821	77.9	5.63	0	0	0	0	0	2
		5	96.0	28.0	5,990	67.0	5.19	0	0	0	0	2	3
	0.71	2	86.2	32.5	5,368	71.7	3.93	0	0	0	0	0	0
		3	90.8	32.5	5,772	71.7	4.96	2	2	2	0	0	0
		4	92.3	32.5	6,071	71.7	5.10	2	2	2	2	4	0
		4	93.8	30.0	5,708	66.4	5.39	0	0	0	2	0	0
		4	93.0	25.0	5,006	54.5	6.64	1	1	1	1	1	0
		5	95.4	32.5	6,209	71.7	5.63	0	0	0	0	0	2
		5	96.0	28.0	5,453	61.6	5.19	0	0	0	0	0	3
Total								**100**	**100**	**100**	**100**	**100**	**100**

Table 10.22 Standards-Case Initial Ballast Market-Share Matrix for Four-Foot T8 Medium Bipin Systems (Roll-up Scenario)

Mix of New Lamps Purchased as Replacements on Ballasts Installed before 2011 at Various Trial Standard Levels													
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case	TSL1	TSL2	TSL3	TSL4	TSL5
			lm/W	W	lm	W	$	%	%	%	%	%	%
Electronic Ballast Factor	0.88	2	86.2	32.5	6,653	86.8	3.93	49	49	49	0	0	0
		3	90.8	32.5	7,154	86.8	4.96	25	25	25	74	0	0
		4	92.3	32.5	7,524	86.8	5.10	6	6	6	6	31	0
		4	93.8	30.0	7,075	80.4	5.39	1	1	1	1	1	0
		4	93.0	25.0	6,204	66.5	6.64	2	2	2	2	2	0
		5	95.4	32.5	7,696	86.8	5.63	4	4	4	4	4	10
		5	96.0	28.0	6,758	69.7	5.19	3	3	3	3	52	80
	0.78	2	86.2	32.5	5,897	77.9	3.93	0	0	0	0	0	0
		3	90.8	32.5	6,341	77.9	4.96	2	2	2	2	0	0
		4	92.3	32.5	6,669	77.9	5.10	2	2	2	2	4	0
		4	93.8	30.0	6,271	72.2	5.39	0	0	0	0	0	0
		4	93.0	25.0	5,499	59.4	6.64	1	1	1	1	1	0
		5	95.4	32.5	6,821	77.9	5.63	0	0	0	0	0	2
		5	96.0	28.0	5,990	67.0	5.19	0	0	0	0	0	3
	0.71	2	86.2	32.5	5,368	71.7	3.93	0	0	0	0	0	0
		3	90.8	32.5	5,772	71.7	4.96	2	2	2	2	0	0
		4	92.3	32.5	6,071	71.7	5.10	2	2	2	2	4	0
		4	93.8	30.0	5,708	66.4	5.39	0	0	0	0	0	0
		4	93.0	25.0	5,006	54.5	6.64	1	1	1	1	1	0
		5	95.4	32.5	6,209	71.7	5.63	0	0	0	0	0	2
		5	96.0	28.0	5,453	61.6	5.19	0	0	0	0	0	3
							Total	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.23 Standards-Case Initial Ballast Market-Share Matrix for Four-Foot T12 Medium Bipin Systems in the Commercial Sector (Shift and Roll-up Scenarios)

Mix of New Lamps Purchased as Replacements on Ballasts Installed before 2010 at Various Trial Standard Levels												
	EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case	TSL1	TSL2	TSL3	TSL4	TSL5
		lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*
Magnetic Ballast	0	78.0	40	8,208	129	4.60	0	0	0	0	0	0
	0	77.9	34	6,072	108	3.68	58	0	0	0	0	0
	1	80.5	40	8,550	129	6.80	20	20	0	0	0	0
	1	82.4	34	6,494	108	4.91	6	64	0	0	0	0
	1	82.9	40	8,721	129	8.35	8	8	0	0	0	0
	2	85.3	34	6,890	108	7.25	2	2	66	0	0	0
	2	87.8	40	9,263	129	8.45	5	5	33	0	0	0
	3	91.2	34	7,366	108	8.32	1	1	1	100	0	0
						Total	**100**	**100**	**100**	**100**	**0**	**0**

Table 10.24 Standards-Case Initial Ballast Market-Share Matrix for Four-Foot T12 Medium Bipin Systems in the Residential Sector (Shift and Roll-up Scenarios)

Mix of New Lamps Purchased as Replacements on Ballasts Installed before 2010 at Various Trial Standard Levels												
	EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case	TSL1	TSL2	TSL3	TSL4	TSL5
		lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*
Magnetic Ballast	0	76.8	40	15,000	70	1.99	75	0	0	0	0	0
	1	80.5	40	20,000	70	4.72	15	15	0	0	0	0
	1	82.4	34	20,000	60	2.82	0	0	0	0	0	0
	1	82.9	40	24,000	70	6.27	5	5	0	0	0	0
	2	85.3	34	20,000	60	5.17	0	0	0	0	0	0
	2	87.8	40	24,000	70	6.36	5	5	25	0	0	0
	3	91.2	34	24,000	60	6.23	0	75	75	100	0	0
						Total	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.25 Standards-Case New Ballast Market-Share Matrix for Four-Foot T8 Medium Bipin Systems in the Commercial Sector (Shift Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	2	86.2	32.5	6,653	86.8	3.93	49	20	49	20	49	20	0	0	0	0	0	0
		3	90.8	32.5	7,154	86.8	4.96	25	3	25	3	25	3	0	0	0	0	0	0
		4	92.3	32.5	7,524	86.8	5.10	6	0	6	0	6	0	6	0	6	0	0	0
		4	93.8	30.0	7,075	80.4	5.39	1	10	1	10	1	10	0	0	0	0	0	0
		4	93.0	25.0	6,204	66.5	6.64	2	15	2	15	2	15	2	0	0	0	0	0
		5	95.4	32.5	7,696	86.8	5.63	4	0	4	0	4	0	4	0	4	0	10	0
		5	96.0	28.0	6,758	69.7	5.19	3	18	3	18	3	18	6	30	31	33	80	53
	0.78	2	86.2	32.5	5,897	77.9	3.93	0	0	0	0	0	0	0	0	0	0	0	0
		3	90.8	32.5	6,341	77.9	4.96	2	0	2	0	2	0	49	20	0	0	0	0
		4	92.3	32.5	6,669	77.9	5.10	2	2	2	2	2	2	25	3	0	0	0	0
		4	93.8	30.0	6,271	72.2	5.39	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25.0	5,499	59.4	6.64	1	20	1	20	1	20	0	0	0	0	0	0
		5	95.4	32.5	6,821	77.9	5.63	0	0	0	0	0	0	0	0	0	0	0	0
		5	96.0	28.0	5,990	67	5.19	0	2	0	2	0	2	4	17	6	17	6	17
	0.71	2	86.2	32.5	5,368	71.7	3.93	0	0	0	0	0	0	0	0	0	0	0	0
		3	90.8	32.5	5,772	71.7	4.96	2	0	2	0	2	0	0	0	0	0	0	0
		4	92.3	32.5	6,071	71.7	5.10	2	0	2	0	2	0	0	0	51	20	0	0
		4	93.8	30.0	5,708	66.4	5.39	0	0	0	0	0	0	2	0	0	0	0	0
		4	93.0	25.0	5,006	54.5	6.64	1	10	1	10	1	10	1	10	1	10	0	0
		5	95.4	32.5	6,209	71.7	5.63	0	0	0	0	0	0	0	0	0	0	0	0
		5	96.0	28.0	5,453	61.6	5.19	0	0	0	0	0	0	1	20	1	20	4	30
							Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.26 Standards-Case New Ballast Market-Share Matrix for Four-Foot T8 Medium Bipin Systems in the Commercial Sector (Roll-Up Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		TSL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	**0.88**	2	86.2	32.5	6,653	86.8	3.93	49	20	49	20	49	20	0	0	0	0	0	0
		3	90.8	32.5	7,154	86.8	4.96	25	3	25	3	25	3	25	3	0	0	0	0
		4	92.3	32.5	7,524	86.8	5.10	6	0	6	0	6	0	6	0	31	3	0	0
		4	93.8	30.0	7,075	80.4	5.39	1	10	1	10	1	10	1	10	1	10	0	0
		4	93.0	25.0	6,204	66.5	6.64	2	15	2	15	2	15	2	15	2	15	0	0
		5	95.4	32.5	7,696	86.8	5.63	4	0	4	0	4	0	4	0	4	0	10	0
		5	96.0	28.0	6,758	69.7	5.19	3	18	3	18	3	18	3	18	3	18	80	53
	0.78	2	86.2	32.5	5,897	77.9	3.93	0	0	0	0	0	0	0	0	0	0	0	0
		3	90.8	32.5	6,341	77.9	4.96	2	0	2	0	2	0	51	20	0	0	0	0
		4	92.3	32.5	6,669	77.9	5.10	2	2	2	2	2	2	2	2	51	22	0	0
		4	93.8	30.0	6,271	72.2	5.39	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25.0	5,499	59.4	6.64	1	20	1	20	1	20	1	20	1	20	0	0
		5	95.4	32.5	6,821	77.9	5.63	0	0	0	0	0	0	0	0	0	0	0	0
		5	96.0	28.0	5,990	67	5.19	0	2	0	2	0	2	0	2	0	2	8	17
	0.71	2	86.2	32.5	5,368	71.7	3.93	0	0	0	0	0	0	0	0	0	0	0	0
		3	90.8	32.5	5,772	71.7	4.96	2	0	2	0	2	0	2	0	0	0	0	0
		4	92.3	32.5	6,071	71.7	5.10	2	0	2	0	2	0	2	0	6	0	0	0
		4	93.8	30.0	5,708	66.4	5.39	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25.0	5,006	54.5	6.64	1	10	1	10	1	10	1	10	1	10	0	0
		5	95.4	32.5	6,209	71.7	5.63	0	0	0	0	0	0	0	0	0	0	0	0
		5	96.0	28.0	5,453	61.6	5.19	0	0	0	0	0	0	0	0	0	0	2	30
							Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

As discussed above, depicts the 4-foot T8 medium bipin new ballast market share matrix for those consumers characterized by the Market Segment-Based expertise scenario. The selection of Shift or Roll-up has no affect on these consumers—they only roll-up in the standards-case. As Table 10.27 illustrates, there is no migration to lower ballast factors with increasing standards. In contrast, in the High expertise scenario, consumers do migrate to lower ballast factors, as shown in Table 10.25. To view the market share matrices characterizing consumers with market segment-based expertise, please see the NIA spreadsheet.

Table 10.27 Standards-Case New Ballast Market-Share Matrix for Four-Foot T8 Medium Bipin Systems in the Commercial Sector (No Lighting Expertise Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	2	86.2	32.5	6,653	86.8	3.93	49	20	49	20	49	20	0	0	0	0	0	0
		3	90.8	32.5	7,154	86.8	4.96	25	3	25	3	25	3	74	23	0	0	0	0
		4	92.3	32.5	7,524	86.8	5.10	6	0	6	0	6	0	6	0	80	23	0	0
		4	93.8	30.0	7,075	80.4	5.39	1	10	1	10	1	10	1	10	1	10	0	0
		4	93.0	25.0	6,204	66.5	6.64	2	15	2	15	2	15	2	15	2	15	0	0
		5	95.4	32.5	7,696	86.8	5.63	4	0	4	0	4	0	4	0	4	0	84	23
		5	96.0	28.0	6,758	69.7	5.19	3	18	3	18	3	18	3	18	3	18	6	43
	0.78	2	86.2	32.5	5,897	77.9	3.93	0	0	0	0	0	0	0	0	0	0	0	0
		3	90.8	32.5	6,341	77.9	4.96	2	0	2	0	2	0	2	0	0	0	0	0
		4	92.3	32.5	6,669	77.9	5.10	2	2	2	2	2	2	2	2	4	2	0	0
		4	93.8	30.0	6,271	72.2	5.39	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25.0	5,499	59.4	6.64	1	20	1	20	1	20	1	20	1	20	0	0
		5	95.4	32.5	6,821	77.9	5.63	0	0	0	0	0	0	0	0	0	0	4	2
		5	96.0	28.0	5,990	67	5.19	0	2	0	2	0	2	0	2	0	2	1	22
	0.71	2	86.2	32.5	5,368	71.7	3.93	0	0	0	0	0	0	0	0	0	0	0	0
		3	90.8	32.5	5,772	71.7	4.96	2	0	2	0	2	0	2	0	0	0	0	0
		4	92.3	32.5	6,071	71.7	5.10	2	0	2	0	2	0	2	0	4	0	0	0
		4	93.8	30.0	5,708	66.4	5.39	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25.0	5,006	54.5	6.64	1	10	1	10	1	10	1	10	1	10	0	0
		5	95.4	32.5	6,209	71.7	5.63	0	0	0	0	0	0	0	0	0	0	4	0
		5	96.0	28.0	5,453	61.6	5.19	0	0	0	0	0	0	0	0	0	0	1	10
Total								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.28 Standards-Case New Ballast Market-Share Matrix for Four-Foot T8 Medium Bipin Systems in the Residential Sector (Shift Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	**0.88**	2	86.2	32.5	20,000	58.6	1.84	10	10	10	10	10	10	0	0	0	0	0	0
		3	90.8	32.5	20,000	58.6	2.88	5	5	5	5	5	5	0	0	0	0	0	0
		4	92.3	32.5	24,000	58.6	3.02	6	6	6	6	6	6	6	6	6	6	0	0
		4	93.8	30.0	20,000	54.6	3.30	1	1	1	1	1	1	0	0	0	0	0	0
		4	93.0	25.0	30,000	45.4	4.56	2	2	2	2	2	2	9	9	0	0	0	0
		5	95.4	32.5	24,000	58.6	3.54	0	0	0	0	0	0	0	0	0	0	6	6
		5	96.0	28.0	18,000	51.2	3.10	3	3	3	3	3	3	6	6	11	11	21	21
	0.78	2	86.2	32.5	20,000	51.6	1.84	10	10	10	10	10	10	0	0	0	0	0	0
		3	90.8	32.5	20,000	51.6	2.88	9	9	9	9	9	9	10	10	0	0	0	0
		4	92.3	32.5	24,000	51.6	3.02	2	2	2	2	2	2	5	5	0	0	0	0
		4	93.8	30.0	20,000	48.9	3.30	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25.0	30,000	40.5	4.56	1	1	1	1	1	1	0	0	0	0	0	0
		5	95.4	32.5	24,000	51.6	3.54	2	2	2	2	2	2	2	2	2	2	2	2
		5	96.0	28.0	18,000	45.6	3.10	0	0	0	0	0	0	4	4	13	13	13	13
	0.71	2	86.2	32.5	20,000	46.8	1.84	29	29	29	29	29	29	0	0	0	0	0	0
		3	90.8	32.5	20,000	46.8	2.88	15	15	15	15	15	15	39	39	0	0	0	0
		4	92.3	32.5	24,000	46.8	3.02	2	2	2	2	2	2	0	0	35	35	0	0
		4	93.8	30.0	20,000	44.9	3.30	0	0	0	0	0	0	15	15	0	0	0	0
		4	93.0	25.0	30,000	37.0	4.56	1	1	1	1	1	1	1	1	1	1	0	0
		5	95.4	32.5	24,000	46.8	3.54	2	2	2	2	2	2	2	2	2	2	2	2
		5	96.0	28.0	18,000	41.7	3.10	0	0	0	0	0	0	1	1	30	30	56	56
Total								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.29 Standards-Case New Ballast Market-Share Matrix for Four-Foot T8 Medium Bipin Systems in the Residential Sector (Roll-Up Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																				
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	W	lm	W	$	%	%	%	%	%	%	%	%	%	%	%	%
Electronic Ballast Factor	0.88	2	86.2	32.5	20,000	58.6	1.84	10	10	10	10	10	10	0	0	0	0	0	0
		3	90.8	32.5	20,000	58.6	2.88	5	5	5	5	5	5	5	5	0	0	0	0
		4	92.3	32.5	24,000	58.6	3.02	6	6	6	6	6	6	6	6	11	11	0	0
		4	93.8	30.0	20,000	54.6	3.30	1	1	1	1	1	1	1	1	1	1	0	0
		4	93.0	25.0	30,000	45.4	4.56	2	2	2	2	2	2	2	2	2	2	0	0
		5	95.4	32.5	24,000	58.6	3.54	0	0	0	0	0	0	0	0	0	0	6	6
		5	96.0	28.0	18,000	51.2	3.10	3	3	3	3	3	3	3	3	3	3	21	21
	0.78	2	86.2	32.5	20,000	51.6	1.84	10	10	10	10	10	10	0	0	0	0	0	0
		3	90.8	32.5	20,000	51.6	2.88	9	9	9	9	9	9	19	19	0	0	0	0
		4	92.3	32.5	24,000	51.6	3.02	2	2	2	2	2	2	2	2	12	12	0	0
		4	93.8	30.0	20,000	48.9	3.30	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25.0	30,000	40.5	4.56	1	1	1	1	1	1	1	1	1	1	0	0
		5	95.4	32.5	24,000	51.6	3.54	2	2	2	2	2	2	2	2	2	2	2	2
		5	96.0	28.0	18,000	45.6	3.10	0	0	0	0	0	0	0	0	0	0	38	38
	0.71	2	86.2	32.5	20,000	46.8	1.84	29	29	29	29	29	29	0	0	0	0	0	0
		3	90.8	32.5	20,000	46.8	2.88	15	15	15	15	15	15	54	54	0	0	0	0
		4	92.3	32.5	24,000	46.8	3.02	2	2	2	2	2	2	2	2	36	36	0	0
		4	93.8	30.0	20,000	44.9	3.30	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25.0	30,000	37.0	4.56	1	1	1	1	1	1	1	1	1	1	0	0
		5	95.4	32.5	24,000	46.8	3.54	2	2	2	2	2	2	2	2	2	2	2	2
		5	96.0	28.0	18,000	41.7	3.10	0	0	0	0	0	0	0	0	29	29	31	31
Total								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.30 Standards-Case New Ballast Market-Share Matrix for Four-Foot T12 Medium Bipin Systems in the Commercial Sector (Shift Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	0	78.0	40	7,603	107.7	4.60	0	0	0	0	0	0	0	0	0	0	0	0
		0	77.9	34	6,072	91.7	3.68	58	58	0	0	0	0	0	0	0	0	0	0
		1	80.5	40	7,920	107.7	6.80	20	20	0	0	0	0	0	0	0	0	0	0
		1	82.4	34	6,494	91.7	4.91	6	6	0	0	0	0	0	0	0	0	0	0
		1	82.9	40	8,078	107.7	8.35	8	8	0	0	0	0	0	0	0	0	0	0
		2	85.3	34	6,890	91.7	7.25	2	2	0	0	0	0	0	0	0	0	0	0
		2	87.8	40	8,580	107.7	8.45	5	5	5	5	5	5	0	0	0	0	0	0
		3	91.2	34	7,366	91.7	8.32	1	1	1	1	29	29	34	34	0	0	0	0
	0.86	0	78.0	40	7,430	106.3	4.60	0	0	0	0	0	0	0	0	0	0	0	0
		0	77.9	34	5,934	90.3	3.68	0	0	0	0	0	0	0	0	0	0	0	0
		1	80.5	40	7,740	106.3	6.80	0	0	0	0	0	0	0	0	0	0	0	0
		1	82.4	34	6,347	90.3	4.91	0	0	58	58	0	0	0	0	0	0	0	0
		1	82.9	40	7,895	106.3	8.35	0	0	0	0	0	0	0	0	0	0	0	0
		2	85.3	34	6,734	90.3	7.25	0	0	6	6	58	58	0	0	0	0	0	0
		2	87.8	40	8,385	106.3	8.45	0	0	28	28	0	0	0	0	0	0	0	0
		3	91.2	34	7,198	90.3	8.32	0	0	2	2	8	8	66	66	0	0	0	0
Total								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.31 Standards-Case New Ballast Market-Share Matrix for Four-Foot T12 Medium Bipin Systems in the Commercial Sector (Roll-up Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																				
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	%	%	%	%	%	%	%	%	%	%	%	%
Electronic Ballast Factor	0.88	0	78.0	40	7,603	107.7	4.60	0	0	0	0	0	0	0	0	0	0	0	0
		0	77.9	34	6,072	91.7	3.68	58	58	0	0	0	0	0	0	0	0	0	0
		1	80.5	40	7,920	107.7	6.80	20	20	20	20	0	0	0	0	0	0	0	0
		1	82.4	34	6,494	91.7	4.91	6	6	6	6	0	0	0	0	0	0	0	0
		1	82.9	40	8,078	107.7	8.35	8	8	8	8	0	0	0	0	0	0	0	0
		2	85.3	34	6,890	91.7	7.25	2	2	2	2	2	2	0	0	0	0	0	0
		2	87.8	40	8,580	107.7	8.45	5	5	5	5	5	5	0	0	0	0	0	0
		3	91.2	34	7,366	91.7	8.32	1	1	1	1	29	29	34	34	0	0	0	0
	0.86	0	78.0	40	7,430	106.3	4.60	0	0	0	0	0	0	0	0	0	0	0	0
		0	77.9	34	5,934	90.3	3.68	0	0	0	0	0	0	0	0	0	0	0	0
		1	80.5	40	7,740	106.3	6.80	0	0	0	0	0	0	0	0	0	0	0	0
		1	82.4	34	6,347	90.3	4.91	0	0	58	58	0	0	0	0	0	0	0	0
		1	82.9	40	7,895	106.3	8.35	0	0	0	0	0	0	0	0	0	0	0	0
		2	85.3	34	6,734	90.3	7.25	0	0	0	0	64	64	0	0	0	0	0	0
		2	87.8	40	8,385	106.3	8.45	0	0	0	0	0	0	0	0	0	0	0	0
		3	91.2	34	7,198	90.3	8.32	0	0	0	0	0	0	66	66	0	0	0	0
							Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	100	100	100	100	100

Table 10.32 Standards-Case New Ballast Market-Share Matrix for Four-Foot T12 Medium Bipin Systems in the Residential Sector (Shift Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																				
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.68	0	76.8	40	15,000	70	1.99	38	38	0	0	0	0	0	0	0	0	0	0
	0.68	1	80.5	40	20,000	70	4.72	7	7	0	0	0	0	0	0	0	0	0	0
	0.66	1	82.4	34	20,000	60	2.82	0	0	0	0	0	0	0	0	0	0	0	0
	0.68	1	82.9	40	24,000	70	6.27	3	3	0	0	0	0	0	0	0	0	0	0
	0.66	2	85.3	34	20,000	60	5.17	0	0	0	0	0	0	0	0	0	0	0	0
	0.68	2	87.8	40	24,000	70	6.36	2	2	0	0	0	0	0	0	0	0	0	0
	0.66	3	91.2	34	24,000	60	6.23	0	0	0	0	0	0	0	0	0	0	0	0
	0.65	0	76.8	40	15,000	58	1.99	37	37	0	0	0	0	0	0	0	0	0	0
	0.65	1	80.5	40	20,000	58	4.72	8	8	0	0	0	0	0	0	0	0	0	0
	0.75	1	82.4	34	20,000	48	2.82	0	0	75	75	0	0	0	0	0	0	0	0
	0.65	1	82.9	40	24,000	58	6.27	2	2	0	0	0	0	0	0	0	0	0	0
	0.75	2	85.3	34	20,000	48	5.17	0	0	17	17	75	75	0	0	0	0	0	0
	0.65	2	87.8	40	24,000	58	6.36	3	3	3	3	0	0	0	0	0	0	0	0
	0.75	3	91.2	34	24,000	48	6.23	0	0	5	5	25	25	100	100	0	0	0	0
Total								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.33 Standards-Case New Ballast Market-Share Matrix for Four-Foot T12 Medium Bipin Systems in the Residential Sector (Roll-up Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		EL	**Lamp Efficacy**	**Lamp Wattage**	**System Lumens**	**System Input Power**	**Installed Lamp Price**	**Base Case**		**TSL1**		**TSL2**		**TSL3**		**TSL4**		**TSL5**	
								2012	**2042**	**2012**	**2042**	**2012**	**2042**	**2012**	**2042**	**2012**	**2042**	**2012**	**2042**
			lm/W	***W***	***lm***	***W***	***$***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***
Electronic Ballast Factor	0.68	0	76.8	40	15,000	70	1.99	38	38	0	0	0	0	0	0	0	0	0	0
	0.68	1	80.5	40	20,000	70	4.72	7	7	7	7	0	0	0	0	0	0	0	0
	0.66	1	82.4	34	20,000	60	2.82	0	0	0	0	0	0	0	0	0	0	0	0
	0.68	1	82.9	40	24,000	70	6.27	3	3	3	3	0	0	0	0	0	0	0	0
	0.66	2	85.3	34	20,000	60	5.17	0	0	0	0	0	0	0	0	0	0	0	0
	0.68	2	87.8	40	24,000	70	6.36	2	2	2	2	2	2	0	0	0	0	0	0
	0.66	3	91.2	34	24,000	60	6.23	0	0	0	0	0	0	38	38	0	0	0	0
	0.65	0	76.8	40	15,000	58	1.99	37	37	0	0	0	0	0	0	0	0	0	0
	0.65	1	80.5	40	20,000	58	4.72	8	8	8	8	0	0	0	0	0	0	0	0
	0.75	1	82.4	34	20,000	48	2.82	0	0	75	75	0	0	0	0	0	0	0	0
	0.65	1	82.9	40	24,000	58	6.27	2	2	2	2	0	0	0	0	0	0	0	0
	0.75	2	85.3	34	20,000	48	5.17	0	0	0	0	92	92	0	0	0	0	0	0
	0.65	2	87.8	40	24,000	58	6.36	3	3	3	3	3	3	0	0	0	0	0	0
	0.75	3	91.2	34	24,000	48	6.23	0	0	0	0	3	3	62	62	0	0	0	0
Total								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.34 Standards-Case Initial Ballast Market-Share Matrix for Eight-Foot T8 Single Pin Slimline Systems (Shift Scenario)

Mix of New Lamps Purchased as Replacements on Ballasts Installed before 2011 at Various Trial Standard Levels													
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case	TSL1	TSL2	TSL3	TSL4	TSL5
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	3	94.8	60.1	9,029	112.8	6.31	40	40	40	40	0	0
		4	98.2	60.1	9,553	112.8	8.50	30	30	30	30	0	0
		5	101.5	60.1	10,199	112.8	9.35	6	6	6	6	6	6
		5	101.8	57.0	9,592	107.5	8.69	5	5	5	5	5	5
		5	103.6	55.0	9,530	102.0	8.29	5	5	5	5	75	75
	0.85	3	94.8	60.1	8,721	109.1	6.31	3	3	3	3	0	0
		4	98.2	60.1	9,228	109.1	8.50	2	2	2	2	0	0
		5	101.5	60.1	9,852	109.1	9.35	2	2	2	2	2	2
		5	101.8	57.0	9,265	106.0	8.69	0	0	0	0	0	0
		5	103.6	55.0	9,206	98.5	8.29	0	0	0	0	5	5
	0.78	3	94.8	60.1	8,003	100.4	6.31	3	3	3	3	0	0
		4	98.2	60.1	8,468	100.4	8.50	2	2	2	2	0	0
		5	101.5	60.1	9,040	100.4	9.35	2	2	2	2	2	2
		5	101.8	57.0	8,502	102.5	8.69	0	0	0	0	0	0
		5	103.6	55.0	8,447	90.2	8.29	0	0	0	0	5	5
Total								**100**	**100**	**100**	**100**	**100**	**100**

Table 10.35 Standards-Case Initial Ballast Market-Share Matrix for Eight-Foot T8 Single Pin Slimline Systems (Roll-up Scenario)

Mix of New Lamps Purchased as Replacements on Ballasts Installed before 2011 at Various Trial Standard Levels														
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case	TSL1	TSL2	TSL3	TSL4	TSL5
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	3	94.8	60.1	9,029	112.8	6.31	40	40	40	40	0	0
		4	98.2	60.1	9,553	112.8	8.50	30	30	30	30	30	0
		5	101.5	60.1	10,199	112.8	9.35	6	6	6	6	6	6
		5	101.8	57.0	9,592	107.5	8.69	5	5	5	5	5	5
		5	103.6	55.0	9,530	102.0	8.29	5	5	5	5	45	75
	0.85	3	94.8	60.1	8,721	109.1	6.31	3	3	3	3	0	0
		4	98.2	60.1	9,228	109.1	8.50	2	2	2	2	2	0
		5	101.5	60.1	9,852	109.1	9.35	2	2	2	2	2	2
		5	101.8	57.0	9,265	106.0	8.69	0	0	0	0	0	0
		5	103.6	55.0	9,206	98.5	8.29	0	0	0	0	3	5
	0.78	3	94.8	60.1	8,003	100.4	6.31	3	3	3	3	0	0
		4	98.2	60.1	8,468	100.4	8.50	2	2	2	2	2	0
		5	101.5	60.1	9,040	100.4	9.35	2	2	2	2	2	2
		5	101.8	57.0	8,502	102.5	8.69	0	0	0	0	0	0
		5	103.6	55.0	8,447	90.2	8.29	0	0	0	0	3	5
Total								**100**	**100**	**100**	**100**	**100**	**100**

Table 10.36 Standards-Case Initial Ballast Market-Share Matrix for Eight-Foot T12 Single Pin Slimline Systems (Shift and Roll-up Scenarios)

Mix of New Lamps Purchased as Replacements on Ballasts Installed before 2010 at Various Trial Standard Levels												
	EL	**Lamp Efficacy**	**Lamp Wattage**	**System Lumens**	**System Input Power**	**Installed Lamp Price**	**Base Case Mix of Systems Installed before 2010**	**TSL1**	**TSL2**	**TSL3**	**TSL4**	**TSL5**
		lm/W	***W***	***lm***	***W***	***$***	***%***	***%***	***%***	***%***	***%***	***%***
Magnetic Ballast	0	85.6	75.0	11,103	158	8.02	46	0	0	0	0	0
	1	87.3	75.0	11,575	158	11.21	16	62	0	0	0	0
	1	87.6	60.5	8,209	126	5.60	15	15	0	0	0	0
	2	92.0	75.0	11,976	158	12.16	1	1	63	0	0	0
	2	92.6	60.5	9,068	126	7.94	15	15	30	0	0	0
	3	97.5	60.5	9,645	126	9.66	7	7	7	100	0	0
						Total	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.37 Standards-Case New Ballast Market-Share Matrix for Eight-Foot T8 Single Pin Slimline Systems (Shift Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																				
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	3	94.8	60.1	9,029	112.8	6.31	40	6	40	6	40	6	40	6	0	0	0	0
		4	98.2	60.1	9,553	112.8	8.50	30	11	30	11	30	11	30	11	0	0	0	0
		5	101.5	60.1	10,199	112.8	9.35	6	11	6	11	6	11	6	11	6	11	6	11
		5	101.8	57.0	9,592	107.5	8.69	5	6	5	6	5	6	5	6	5	6	5	6
		5	103.6	55.0	9,530	102.0	8.29	5	6	5	6	5	6	5	6	5	6	5	6
	0.85	3	94.8	60.1	8,721	109.1	6.31	3	7	3	7	3	7	3	7	0	0	0	0
		4	98.2	60.1	9,228	109.1	8.50	2	8	2	8	2	8	2	8	0	0	0	0
		5	101.5	60.1	9,852	109.1	9.35	2	6	2	6	2	6	2	6	2	6	2	6
		5	101.8	57.0	9,265	106.0	8.69	0	6	0	6	0	6	0	6	0	6	0	6
		5	103.6	55.0	9,206	98.5	8.29	0	6	0	6	0	6	0	6	30	17	30	17
	0.78	3	94.8	60.1	8,003	100.4	6.31	3	7	3	7	3	7	3	7	0	0	0	0
		4	98.2	60.1	8,468	100.4	8.50	2	8	2	8	2	8	2	8	0	0	0	0
		5	101.5	60.1	9,040	100.4	9.35	2	6	2	6	2	6	2	6	2	6	2	6
		5	101.8	57.0	8,502	102.5	8.69	0	3	0	3	0	3	0	3	0	3	0	3
		5	103.6	55.0	8,447	90.2	8.29	0	3	0	3	0	3	0	3	50	39	50	39
							Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.38 Standards-Case New Ballast Market-Share Matrix for Eight-Foot T8 Single Pin Slimline Systems (Roll-up Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	3	94.8	60.1	9,029	112.8	6.31	40	6	40	6	40	6	40	6	0	0	0	0
		4	98.2	60.1	9,553	112.8	8.50	30	11	30	11	30	11	30	11	30	11	0	0
		5	101.5	60.1	10,199	112.8	9.35	6	11	6	11	6	11	6	11	6	11	6	11
		5	101.8	57.0	9,592	107.5	8.69	5	6	5	6	5	6	5	6	5	6	5	6
		5	103.6	55.0	9,530	102.0	8.29	5	6	5	6	5	6	5	6	5	6	35	17
	0.85	3	94.8	60.1	8,721	109.1	6.31	3	7	3	7	3	7	3	7	0	0	0	0
		4	98.2	60.1	9,228	109.1	8.50	2	8	2	8	2	8	2	8	2	8	0	0
		5	101.5	60.1	9,852	109.1	9.35	2	6	2	6	2	6	2	6	2	6	2	6
		5	101.8	57.0	9,265	106.0	8.69	0	6	0	6	0	6	0	6	0	6	0	6
		5	103.6	55.0	9,206	98.5	8.29	0	6	0	6	0	6	0	6	40	12	40	12
	0.78	3	94.8	60.1	8,003	100.4	6.31	3	7	3	7	3	7	3	7	0	0	0	0
		4	98.2	60.1	8,468	100.4	8.50	2	8	2	8	2	8	2	8	2	8	0	0
		5	101.5	60.1	9,040	100.4	9.35	2	6	2	6	2	6	2	6	2	6	2	6
		5	101.8	57.0	8,502	102.5	8.69	0	3	0	3	0	3	0	3	0	3	0	3
		5	103.6	55.0	8,447	90.2	8.29	0	3	0	3	0	3	0	3	6	17	10	33
Total								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.39 Standards-Case New Ballast Market-Share Matrix for Four-Foot T8 Medium Bipin Systems Replacing Eight-Foot Single Pin Slimline Systems (Shift Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	2	86.2	32.5	8,870	117.2	4.91	49	20	49	20	49	20	0	0	0	0	0	0
		3	90.8	32.5	9,539	117.2	5.94	25	3	25	3	25	3	0	0	0	0	0	0
		4	92.3	32.5	10,032	117.2	6.08	6	0	6	0	6	0	6	0	6	0	0	0
		4	93.8	30	9,434	109.2	6.37	1	10	1	10	1	10	0	0	0	0	0	0
		4	93.0	25	8,272	90.8	7.62	2	15	2	15	2	15	2	0	0	0	0	0
		5	95.4	32.5	10,261	117.2	6.61	4	0	4	0	4	0	4	0	4	0	10	0
		5	96.0	28	9,011	102.4	6.17	3	18	3	18	3	18	6	30	31	33	80	53
	0.78	2	86.2	32.5	7,862	103.2	4.91	0	0	0	0	0	0	0	0	0	0	0	0
		3	90.8	32.5	8,455	103.2	5.94	2	0	2	0	2	0	49	20	0	0	0	0
		4	92.3	32.5	8,892	103.2	6.08	2	2	2	2	2	2	25	3	0	0	0	0
		4	93.8	30	8,362	97.8	6.37	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25	7,332	81.0	7.62	1	20	1	20	1	20	0	0	0	0	0	0
		5	95.4	32.5	9,095	103.2	6.61	0	0	0	0	0	0	0	0	0	0	0	0
		5	96.0	28	7,987	91.2	6.17	0	2	0	2	0	2	4	17	6	17	6	17
	0.71	2	86.2	32.5	7,157	93.6	4.91	0	0	0	0	0	0	0	0	0	0	0	0
		3	90.8	32.5	7,696	93.6	5.94	2	0	2	0	2	0	0	0	0	0	0	0
		4	92.3	32.5	8,094	93.6	6.08	2	0	2	0	2	0	0	0	51	20	0	0
		4	93.8	30	7,611	89.8	6.37	0	0	0	0	0	0	2	0	0	0	0	0
		4	93.0	25	6,674	74.0	7.62	1	10	1	10	1	10	1	10	1	10	0	0
		5	95.4	32.5	8,279	93.6	6.61	0	0	0	0	0	0	0	0	0	0	0	0
		5	96.0	28	7,270	83.4	6.17	0	0	0	0	0	0	1	20	1	20	4	30
							Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.40 Standards-Case New Ballast Market-Share Matrix for Four-Foot T8 Medium Bipin Systems Replacing Eight-Foot Single Pin Slimline Systems (Roll-up Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	2	86.2	32.5	8,870	117.2	4.91	49	20	49	20	49	20	0	0	0	0	0	0
		3	90.8	32.5	9,539	117.2	5.94	25	3	25	3	25	3	25	3	0	0	0	0
		4	92.3	32.5	10,032	117.2	6.08	6	0	6	0	6	0	6	0	31	3	0	0
		4	93.8	30	9,434	109.2	6.37	1	10	1	10	1	10	1	10	1	10	0	0
		4	93.0	25	8,272	90.8	7.62	2	15	2	15	2	15	2	15	2	15	0	0
		5	95.4	32.5	10,261	117.2	6.61	4	0	4	0	4	0	4	0	4	0	10	0
		5	96.0	28	9,011	102.4	6.17	3	18	3	18	3	18	3	18	3	18	80	53
	0.78	2	86.2	32.5	7,862	103.2	4.91	0	0	0	0	0	0	0	0	0	0	0	0
		3	90.8	32.5	8,455	103.2	5.94	2	0	2	0	2	0	51	20	0	0	0	0
		4	92.3	32.5	8,892	103.2	6.08	2	2	2	2	2	2	2	2	51	22	0	0
		4	93.8	30	8,362	97.8	6.37	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25	7,332	81.0	7.62	1	20	1	20	1	20	1	20	1	20	0	0
		5	95.4	32.5	9,095	103.2	6.61	0	0	0	0	0	0	0	0	0	0	0	0
		5	96.0	28	7,987	91.2	6.17	0	2	0	2	0	2	0	2	0	2	8	17
	0.71	2	86.2	32.5	7,157	93.6	4.91	0	0	0	0	0	0	0	0	0	0	0	0
		3	90.8	32.5	7,696	93.6	5.94	2	0	2	0	2	0	2	0	0	0	0	0
		4	92.3	32.5	8,094	93.6	6.08	2	0	2	0	2	0	2	0	6	0	0	0
		4	93.8	30	7,611	89.8	6.37	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	25	6,674	74.0	7.62	1	10	1	10	1	10	1	10	1	10	0	0
		5	95.4	32.5	8,279	93.6	6.61	0	0	0	0	0	0	0	0	0	0	0	0
		5	96.0	28	7,270	83.4	6.17	0	0	0	0	0	0	0	0	0	0	2	30
							Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.41 Standards-Case Initial Ballast Market-Share Matrix for Eight-Foot T12 Recessed Double Contact High Output Systems (Shift Scenario)

Mix of New Lamps Purchased as Replacements on Ballasts Installed before 2012 at Various Trial Standard Levels												
	EL	**Lamp Efficacy**	**Lamp Wattage**	**System Lumens**	**System Input Power**	**Installed Lamp Price**	**Base Case Mix of Systems Installed before 2012**	**TSL1**	**TSL2**	**TSL3**	**TSL4**	**TSL5**
		lm/W	***W***	***lm***	***W***	***$***	***%***	***%***	***%***	***%***	***%***	***%***
Magnetic Ballast	0	80.1	113	15,476	237.0	9.79	39	0	0	0	0	0
	0	82.5	97	13,205	203.0	6.88	15	0	0	0	0	0
	1	83.2	113	16,431	237.0	15.56	21	21	0	0	0	0
	2	86.1	97	14,279	203.0	9.95	7	61	61	0	0	0
	3	87.6	97	14,535	203.0	16.11	12	12	33	66	0	0
	3	88.9	97	14,725	203.0	16.42	6	6	6	34	0	0
						Total	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.42 Standards-Case Initial Ballast Market-Share Matrix for Eight-Foot T12 Recessed Double Contact High Output Systems (Roll-up Scenario)

Mix of New Lamps Purchased as Replacements on Ballasts Installed before 2012 at Various Trial Standard Levels													
	EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case Mix of Systems Installed before 2012	TSL1	TSL2	TSL3	TSL4	TSL5
		lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*
Magnetic Ballast	0	80.1	113	15,476	237.0	9.79	39	0	0	0	0	0
	0	82.5	97	13,205	203.0	6.88	15	0	0	0	0	0
	1	83.2	113	16,431	237.0	15.56	21	21	0	0	0	0
	2	86.1	97	14,279	203.0	9.95	7	61	82	0	0	0
	3	87.6	97	14,535	203.0	16.11	12	12	12	94	0	0
	3	88.9	97	14,725	203.0	16.42	6	6	6	6	0	0
						Total	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.43 Standards-Case New Ballast Market-Share Matrix for Eight-Foot T12 Recessed Double Contact High Output New Ballast Systems (Shift Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																				
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	**0.88**	0	80.1	113	15,476	237.0	9.79	20	5	0	0	0	0	0	0	0	0	0	0
		0	82.5	97	13,205	203.0	6.88	7	3	0	0	0	0	0	0	0	0	0	0
		1	83.2	113	16,431	237.0	15.56	11	13	11	13	0	0	0	0	0	0	0	0
		2	86.1	97	14,279	203.0	9.95	3	11	30	17	20	5	0	0	0	0	0	0
		3	87.6	97	14,535	203.0	16.11	6	12	0	0	21	25	20	5	0	0	0	0
		3	88.9	97	14,725	203.0	16.42	3	6	3	6	3	6	19	25	0	0	0	0
	0.89	0	80.1	113	14,335	205.4	9.79	10	2	0	0	0	0	0	0	0	0	0	0
		0	82.5	97	12,232	177.0	6.88	4	2	0	0	0	0	0	0	0	0	0	0
		1	83.2	113	15,220	205.4	15.56	5	6	0	0	0	0	0	0	0	0	0	0
		2	86.1	97	13,226	177.0	9.95	2	5	27	13	27	13	0	0	0	0	0	0
		3	87.6	97	13,464	177.0	16.11	3	7	8	23	3	7	27	15	0	0	0	0
		3	88.9	97	13,640	177.0	16.42	2	4	11	22	14	33	18	43	0	0	0	0
	0.90	0	80.1	113	14,661	211.5	9.79	9	2	0	0	0	0	0	0	0	0	0	0
		0	82.5	97	12,510	185.6	6.88	4	1	0	0	0	0	0	0	0	0	0	0
		1	83.2	113	15,566	211.5	15.56	5	6	0	0	0	0	0	0	0	0	0	0
		2	86.1	97	13,527	185.6	9.95	2	5	9	2	9	2	0	0	0	0	0	0
		3	87.6	97	13,770	185.6	16.11	3	6	0	0	0	0	10	2	0	0	0	0
		3	88.9	97	13,950	185.6	16.42	1	4	1	4	3	9	6	10	0	0	0	0
Total								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.44 Standards-Case New Ballast Market-Share Matrix for Eight-Foot T12 Recessed Double Contact High Output New Ballast Systems (Roll-up Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	0	80.1	113	15,476	237.0	9.79	20	5	0	0	0	0	0	0	0	0	0	0
		0	82.5	97	13,205	203.0	6.88	7	3	0	0	0	0	0	0	0	0	0	0
		1	83.2	113	16,431	237.0	15.56	11	13	11	13	0	0	0	0	0	0	0	0
		2	86.1	97	14,279	203.0	9.95	3	11	42	20	63	45	0	0	0	0	0	0
		3	87.6	97	14,535	203.0	16.11	6	12	6	12	6	12	69	57	0	0	0	0
		3	88.9	97	14,725	203.0	16.42	3	6	3	6	3	6	3	6	0	0	0	0
	0.89	0	80.1	113	14,335	205.4	9.79	10	2	0	0	0	0	0	0	0	0	0	0
		0	82.5	97	12,232	177.0	6.88	4	2	0	0	0	0	0	0	0	0	0	0
		1	83.2	113	15,220	205.4	15.56	5	6	5	6	0	0	0	0	0	0	0	0
		2	86.1	97	13,226	177.0	9.95	2	5	17	11	17	11	0	0	0	0	0	0
		3	87.6	97	13,464	177.0	16.11	3	7	3	7	3	7	22	23	0	0	0	0
		3	88.9	97	13,640	177.0	16.42	2	4	2	4	2	4	2	4	0	0	0	0
	0.90	0	80.1	113	14,661	211.5	9.79	9	2	0	0	0	0	0	0	0	0	0	0
		0	82.5	97	12,510	185.6	6.88	4	1	0	0	0	0	0	0	0	0	0	0
		1	83.2	113	15,566	211.5	15.56	5	6	5	6	0	0	0	0	0	0	0	0
		2	86.1	97	13,527	185.6	9.95	2	5	2	5	2	5	0	0	0	0	0	0
		3	87.6	97	13,770	185.6	16.11	3	6	3	6	3	6	3	6	0	0	0	0
		3	88.9	97	13,950	185.6	16.42	1	4	1	4	1	4	1	4	0	0	0	0
							Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.45 Standards-Case Market-Share Matrix for Eight-Foot T8 Recessed Double Contact High Output New Ballast Systems (Shift Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																			
		EL	**Lamp Efficacy**	**Lamp Wattage**	**System Lumens**	**System Input Power**	**Installed Lamp Price**	**Base Case**		**TSL1**		**TSL2**		**TSL3**		**TSL4**		**TSL5**	
								2012	**2042**	**2012**	**2042**	**2012**	**2042**	**2012**	**2042**	**2012**	**2042**	**2012**	**2042**
			lm/W	***W***	***lm***	***W***	***$***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***
Electronic Ballast Factor	**0.88**	4	91.9	86	12,496	160	9.92	10	10	10	10	10	10	10	10	10	10	0	0
		4	93.0	86	12,672	160	10.09	45	45	45	45	45	45	45	45	45	45	0	0
		5	95.3	86	13,728	160	11.53	45	45	45	45	45	45	45	45	45	45	45	45
	0.81	4	91.9	86	11,502	151	9.92	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	86	11,664	151	10.09	0	0	0	0	0	0	0	0	0	0	0	0
		5	95.3	86	12,636	151	11.53	0	0	0	0	0	0	0	0	0	0	55	55
Total								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.46 Standards-Case Market-Share Matrix for Eight-Foot T8 Recessed Double Contact High Output New Ballast Systems (Roll-up Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels																				
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1		TSL2		TSL3		TSL4		TSL5	
								2012	2042	2012	2042	2012	2042	2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	4	91.9	86	12,496	160	9.92	10	10	10	10	10	10	10	10	10	10	0	0
		4	93.0	86	12,672	160	10.09	45	45	45	45	45	45	45	45	45	45	0	0
		5	95.3	86	13,728	160	11.53	45	45	45	45	45	45	45	45	45	45	45	45
	0.81	4	91.9	86	11,502	151	9.92	0	0	0	0	0	0	0	0	0	0	0	0
		4	93.0	86	11,664	151	10.09	0	0	0	0	0	0	0	0	0	0	0	0
		5	95.3	86	12,636	151	11.53	0	0	0	0	0	0	0	0	0	0	55	55
Total								**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.47 Standards-Case Initial Ballast Market-Share Matrix for Four-Foot T5 Standard Output Systems (Shift Scenario)

Mix of New Systems Purchased before 2012 at Various Trial Standard Levels										
		EL	**Lamp Efficacy**	**Lamp Wattage**	**System Lumens**	**System Input Power**	**Installed Lamp Price**	**Base Case**	**TSL1-TSL4**	**TSL5**
			lm/W	***W***	***lm***	***W***		***%***	***%***	***%***
Electronic Ballast Factor	**1.15**	0	86.0	27.8	3,795	70.7	4.69	14	0	0
		1	104.3	27.8	6,118	70.7	6.58	19	14	0
		2	109.7	27.8	6,665	70.7	7.68	5	5	5
		2	111.5	26	6,118	67.5	7.43	3	22	36
	1.00	0	86.0	27.8	3,300	63.6	4.69	7	0	0
		1	104.3	27.8	5,320	63.6	6.58	18	7	0
		2	109.7	27.8	5,796	63.6	7.68	5	5	5
		2	111.5	26.0	5,320	59.6	7.43	3	21	28
	0.90	0	86.0	27.8	2,970	58.9	4.69	0	0	0
		1	104.3	27.8	4,788	58.9	6.58	18	0	0
		2	109.7	27.8	5,216	58.9	7.68	5	5	5
		2	111.5	26.0	4,788	54.4	7.43	3	21	21
							Total	**100**	**100**	**100**

Table 10.48 Standards-Case Initial Ballast Market-Share Matrix for Four-Foot T5 Standard Output Systems (Roll-up Scenario)

Mix of New Systems Purchased Before 2012 at Various Trial Standard Levels										
		TSL	**Lamp Efficacy**	**Lamp Wattage**	**System Lumens**	**System Input Power**	**Installed Lamp Price**	**Base Case**	**TSL1-TSL4**	**TSL5**
			lm/W	***W***	***lm***	***W***	***S***	***%***	***%***	***%***
Electronic Ballast Factor	**1.15**	0	86.0	27.8	3,795	70.7	4.69	14	0	0
		1	104.3	27.8	6,118	70.7	6.58	19	33	0
		2	109.7	27.8	6,665	70.7	7.68	5	5	5
		2	111.5	26	6,118	67.5	7.43	3	3	36
	1.00	0	86.0	27.8	3,300	63.6	4.69	7	0	0
		1	104.3	27.8	5,320	63.6	6.58	18	25	0
		2	109.7	27.8	5,796	63.6	7.68	5	5	5
		2	111.5	26.0	5,320	59.6	7.43	3	3	28
	0.90	0	86.0	27.8	2,970	58.9	4.69	0	0	0
		1	104.3	27.8	4,788	58.9	6.58	18	18	0
		2	109.7	27.8	5,216	58.9	7.68	5	5	5
		2	111.5	26.0	4,788	54.4	7.43	3	3	21
							Total	**100**	**100**	**100**

Table 10.49 Standards-Case New Ballast Market-Share Matrix for Four-Foot T5 Standard Output New Ballast Systems (Shift Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels														
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1-TSL4		TSL5	
								2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	0.88	0	86.0	27.8	3,795	70.7	4.69	14	14	0	0	0	0
		1	104.3	27.8	6,118	70.7	6.58	19	19	0	0	0	0
		2	109.7	27.8	6,665	70.7	7.68	5	5	5	5	5	5
		2	111.5	26	6,118	67.5	7.43	3	3	3	3	3	3
	0.89	0	86.0	27.8	3,300	63.6	4.69	7	7	0	0	0	0
		1	104.3	27.8	5,320	63.6	6.58	18	18	0	0	0	0
		2	109.7	27.8	5,796	63.6	7.68	5	5	24	24	24	24
		2	111.5	26.0	5,320	59.6	7.43	3	3	3	3	3	3
	0.90	0	86.0	27.8	2,970	58.9	4.69	0	0	0	0	0	0
		1	104.3	27.8	4,788	58.9	6.58	18	18	21	21	0	0
		2	109.7	27.8	5,216	58.9	7.68	5	5	23	23	23	23
		2	111.5	26.0	4,788	54.4	7.43	3	3	21	21	42	42
							Total	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.50 Standards-Case New Ballast Market-Share Matrix for Four-Foot T5 Standard Output New Ballast Systems (Roll-up Scenario)

Mix of New Systems Purchased after 2011 at Various Trial Standard Levels														
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1-TSL4		TSL5	
								2012	2042	2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*	*%*	*%*
Electronic Ballast Factor	**0.88**	0	86.0	27.8	3,795	70.7	4.69	14	14	0	0	0	0
		1	104.3	27.8	6,118	70.7	6.58	19	19	19	19	0	0
		2	109.7	27.8	6,665	70.7	7.68	5	5	5	5	5	5
		2	111.5	26	6,118	67.5	7.43	3	3	3	3	22	22
	0.89	0	86.0	27.8	3,300	63.6	4.69	7	7	0	0	0	0
		1	104.3	27.8	5,320	63.6	6.58	18	18	18	18	0	0
		2	109.7	27.8	5,796	63.6	7.68	5	5	5	5	5	5
		2	111.5	26.0	5,320	59.6	7.43	3	3	3	3	21	21
	0.90	0	86.0	27.8	2,970	58.9	4.69	0	0	0	0	0	0
		1	104.3	27.8	4,788	58.9	6.58	18	18	39	39	0	0
		2	109.7	27.8	5,216	58.9	7.68	5	5	5	5	5	5
		2	111.5	26.0	4,788	54.4	7.43	3	3	3	3	42	42
							Total	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.51 Standards-Case Market-Share Matrix for Four-Foot T5 High Output Initial Ballast Systems (Shift Scenario)

Mix of New Systems Purchased Before 2012 at Various Trial Standard Levels										
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case	TSL1-TSL5
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*
nic Ballast	1.00	0	76.0	53.8	5,770	120.0	5.22	20	0
		1	92.9	53.8	9,200	120.0	7.73	65	20
		1	98.0	51	9,200	117.0	9.92	15	80
Total								**100**	**100**

Table 10.52 Standards-Case Market-Share Matrix for Four-Foot T5 High Output Initial Ballast Systems (Roll-up Scenario)

Mix of New Systems Purchased Before 2012 at Various Trial Standard Levels									
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case	TSL1-TSL5
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*
nic Ballast	1.00	0	76.0	53.8	5,770	120.0	5.22	20	0
		1	92.9	53.8	9,200	120.0	7.73	65	85
		1	98.0	51	9,200	117.0	9.92	15	15
							Total	**100**	**100**

Table 10.53 Standards-Case Market-Share Matrix for Four-Foot T5 High Output New Ballast Systems (Shift Scenario)

Mix of New Systems Purchased After 2011 at Various Trial Standard Levels											
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1-TSL5	
								2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*
nic Ballast	1.00	0	76.0	53.8	5,770	120.0	5.22	20	20	0	0
		1	92.9	53.8	9,200	120.0	7.73	65	65	20	20
		1	98.0	51	9,200	117.0	9.92	15	15	80	80
							Total	**100**	**100**	**100**	**100**

Table 10.54 Standards-Case Market-Share Matrix for Four-Foot T5 High Output New Ballast Systems (Roll-up Scenario)

Mix of New Systems Purchased After 2011 at Various Trial Standard Levels											
		EL	Lamp Efficacy	Lamp Wattage	System Lumens	System Input Power	Installed Lamp Price	Base Case		TSL1-TSL5	
								2012	2042	2012	2042
			lm/W	*W*	*lm*	*W*	*$*	*%*	*%*	*%*	*%*
nic Ballast	1.00	0	76.0	53.8	5,770	120.0	5.22	20	20	0	0
		1	92.9	53.8	9,200	120.0	7.73	65	65	85	85
		1	98.0	51	9,200	117.0	9.92	15	15	15	15
							Total	**100**	**100**	**100**	**100**

10.4.1.3 Early Retirement of Ballasts in the Standards-Cases

The commercial GSFL shipments model incorporates early retirement (or retrofit) of 4-foot T12 medium bipin and 8-foot T12 single pin slimline ballast systems in the standards-case. As historical shipments indicate, in the base case, as magnetic T12 ballasts reach their end of life, these systems are replaced by their electronic T8 counterpart systems. In the standards-cases, DOE assumes that when consumers who own T12 magnetic ballasts are forced to purchase more expensive standards-compliant lamps, some consumers may instead discard their magnetic ballast before its natural end of life to purchase a more cost-effective T8 electronic system. As the standard level and lamp price increase, DOE expects this rate of early ballast retirement to increase as well. Table 10.55 summarizes DOE's assumptions about early ballast retirements in the standards-cases for 4-foot T12 medium bipin and 8-foot T12 single pin slimline ballasts. Percentage annual retrofit rates represent the percentage of remaining T12 installed ballast stock that is retrofitted each year. Similarly, DOE models a higher conversion rate from T12 to T8 systems in the residential sector with higher TSLs, as shown in Table 10.56. Here, when T12 systems reach the natural end of their life, DOE assumes increasing portions of residential consumers will replace those T12 systems with T8 systems at increasing TSLs. At TSL4 and TSL5, all T12 systems are automatically replaced with T8 systems because no T12 lamps are standards-compliant. Figure 10.4.1 depicts how shipments of 4-foot T12 lamps change in response to early retrofit rates, at TSL3, holding the residential conversion rate constant at 0 percent. Similarly, Figure 10.4.2 depicts how shipments of 4-foot T12 lamps change in response to residential conversion rates at TSL3, holding early retirement rates of 4-foot T12 systems constant at 0 percent.

Table 10.55 Early Retirement of Four-Foot T12 Medium Bipin and Eight-Foot Single Pin Slimline Ballasts in the Standards-Cases

Trial Standard Level	Rate of Early Retirement (% of remaining initial ballast stock retired early per year)
1	10
2	15
3	20
4*	25
5*	25

* In addition to voluntary early retirement, T12 ballasts are automatically retrofitted at the end of lamp life because no T12 lamps are standards-compliant

Table 10.56 Conversion of Four-Foot T12 Medium Bipin Systems to T8 Systems in the Standards-Cases in the Residential Sector

Trial Standard Level	Rate of Early Retirement (% of remaining initial ballast stock retired early per year)
1	25
2	35
3	60
4*	N/A
5*	N/A

* T12 ballasts are automatically retrofitted at the end of lamp life because no T12 lamps are standards-compliant

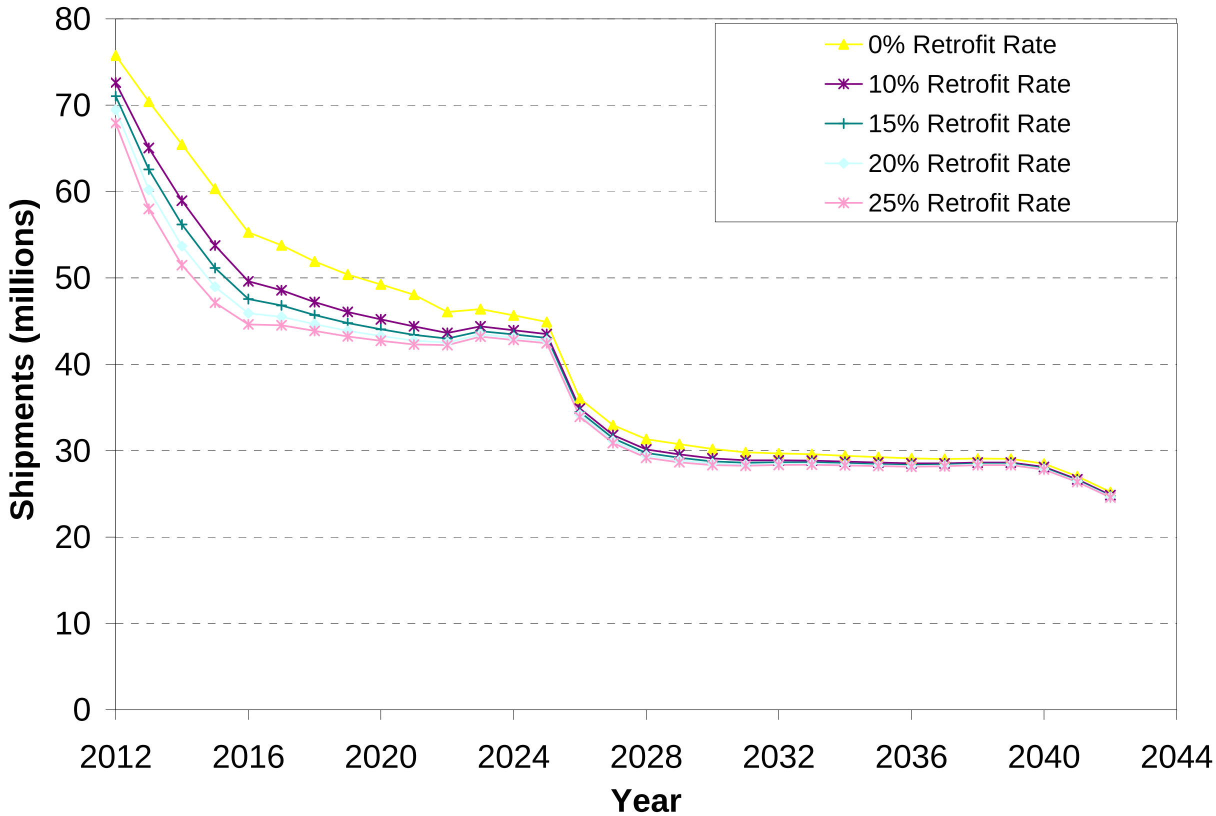

Figure 10.4.1 Retrofit Rate Effect on Four-Foot T12 Shipments at TSL3 in the Emerging, Roll-Up, Market Segment-Based Scenario

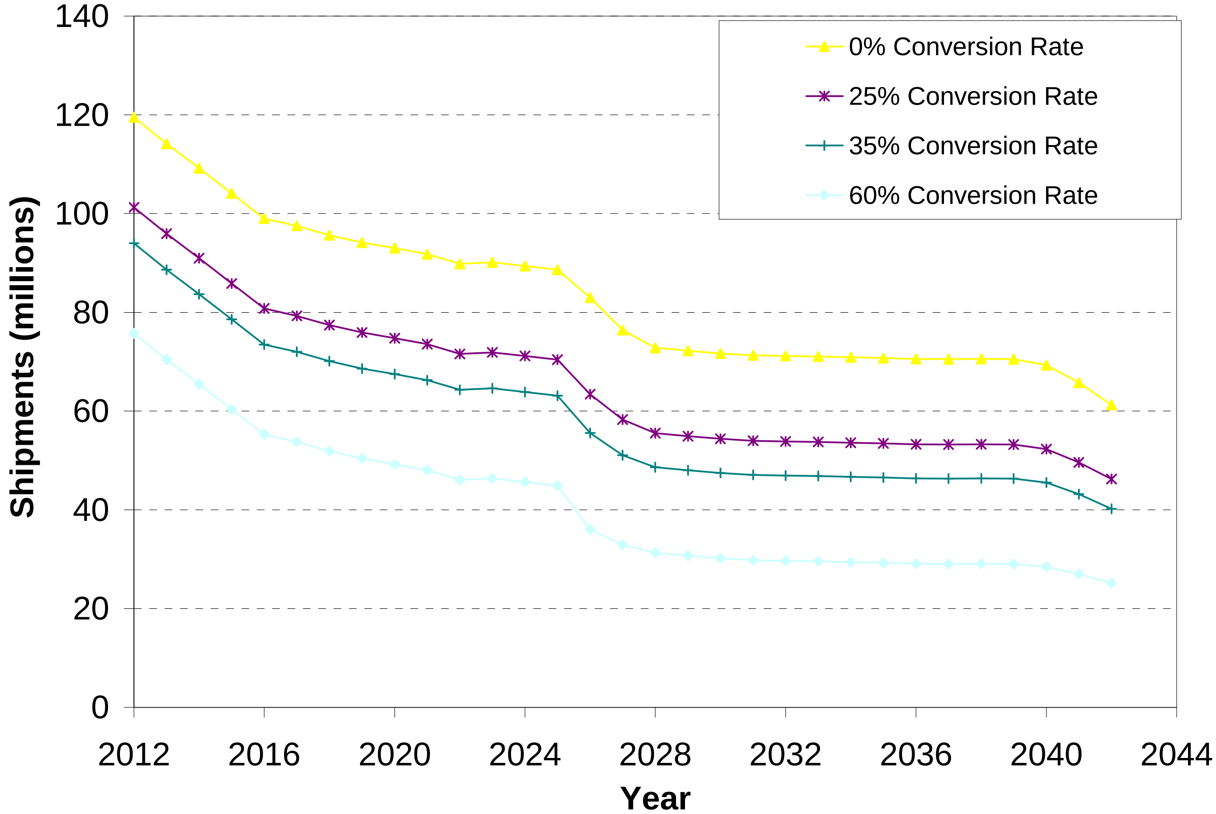

Figure 10.4.2 Residential Conversion Rate Effect on Four-Foot T12 Shipments at TSL3 in the Emerging, Roll-Up, Market Segment-Based Scenario

10.4.2 Incandescent Reflector Lamps

10.4.2.1 Shipments Scenarios

As with GSFL, DOE considers two sets of standards-case scenarios for IRL. The first set of scenarios for IRL includes the "Roll-up" and "Shift" scenarios. Again, the Roll-up scenario represents a standards-case in which all product efficacies in the base case that do not meet the standard would roll up to meet the new standard level. Those product efficacies that were above the standard level are considered unaffected, as consumers continue to purchase the same base case lamp or lamp system. In contrast, the Shift scenario models a standards-case in which *all* base case consumer purchases are affected by the standard (whether or not their base case efficacy meets the standard). In the shift scenario consumers strive to maintain the same efficacy differential (between their purchase and the baseline) in both the base case and standards case. For example, if in the base case, a consumer purchases a lamp at EL3, he is purchase a lamp two market efficacy levels above the baseline (EL1 represents a model lamp not commercially available). Therefore under standards set at TSL3 (corresponding to EL3), that same consumer will purchase IRL at EL5, two efficacy levels above the new baseline.

Because in the residential sector, all consumers purchase at the minimum compliant level, under energy conservation standards all consumers are forced to roll-up to the next highest efficacy level. Therefore, in the residential sector, the Shift and Roll-up scenarios produce the same results. In contrast, the IRL commercial sector responds to the Roll-up or Shift scenario assumptions as GSFL does. Some commercial consumers who purchase lamps above the minimum standard level in the base case may continue to do so in the standards-case.

The second set of standards-case IRL scenarios includes the "Product Substitution" and "No Product Substitution" scenarios. In the Product Substitution scenario, DOE assumes consumers purchasing regulated IRL in the base case do not necessarily continue to purchase regulated IRL in the standards case. DOE thus models a shift to both exempted BR lamps (namely the 65W BR30 lamp) and to R-CFL in the standards-case.

Regarding migration to BR lamps, as discussed earlier, EISA 2007 extended energy conservation standards coverage to certain ER and BR while leaving others exempted. For the product substitution scenario, DOE assumes that as the efficacy standard on IRL increases, some consumers who would normally purchase a covered IRL may instead choose to purchase higher wattage, lower first cost, exempted 65 Watt BR lamps. Although these exempted lamps do not fall under the scope of this rulemaking, DOE includes the effect of consumer migration to these lamps and other technologies in the product substitution scenario.

To estimate the additional migration to exempted BR lamps in the standards-case, DOE calculates PBPs for BR lamps relative to each lamp design (halogen, improved halogen, etc.). Using these PBP values, DOE arrives at market penetration rates by employing the same PBP-market penetration relationship described in section 10.3.3.1. DOE observed that in the commercial sector the predicted market penetration rates of halogen lamps into the BR market are consistent with current market trends. DOE applies the relationship to the higher-efficiency design options, such as HIR, to calculate incremental market penetration of exempted lamps in the standards-case. Specifically, as standards become increasingly stringent and require more efficient technologies, an increasing number of consumers migrate to exempted lamps.

In the residential sector, however, DOE found that the market penetration predicted by the PBP relationship between BR and halogen lamps was not consistent with available market data. DOE concluded residential consumers do not make purchase decisions based on PBP. Therefore, DOE estimated the migration to the exempted lamps based on available data on market trends.

In each sector, DOE apportions the resultant market shares of the analyzed technologies in the market-share matrices.

Additionally, DOE expects increasing residential sector migration to R-CFL in the standards-case as the technology matures and becomes relatively more cost-competitive. DOE uses the same market penetration methodology as it does for the IRL existing and Emerging Technologies base cases. For the residential sector DOE calculates simple payback periods comparing R-CFL to the baseline halogen, and R-CFL to the higher-efficiency lamp designs. Using incremental market penetrations based on the payback period calculations, DOE incorporated additional movement to R-CFL in the residential sector standards-case. As previously discussed, DOE observed that the actual market penetration of R-CFL thus far has been approximately 40 percent of the penetration predicted by the PBP-penetration relationship. DOE believes that R-CFL may not always be appropriate in applications where IRL are used due to differences in color quality, size, dimming capability, and other factors. Therefore, DOE applies scaling-factor reductions of 40 percent for the residential sector. In the commercial sector, DOE assumes that all institutions wishing to convert to R-CFL despites the technology's substitutability issues (such as lower color quality) do so by 2012. Therefore, there is no additional movement to R-CFL in response to standards in the commercial sector.

In the "no production substitution" scenario, DOE assumes consumers who purchase covered IRL technology in the base case continue to purchase covered IRL technology in the standards-case (*i.e.,* the total number of installed covered IRL in the base case is the same as that in the standards-case throughout the analysis period). In this scenario, DOE does not model any additional shift in the standards-case to non-regulated reflector technologies.

As discussed above with GSFL, to evaluate a standards-case, DOE models a standards-case scenario and compares it to the base case. One IRL standards-case scenario, for example, would be the Roll-up, product substitution scenario; another would be the shift, no product substitution scenario. DOE thus considers four IRL standards-case scenarios and two base case scenarios (existing technologies and emerging technologies), yielding eight total sets of results.

In addition to modeling these two sets of scenarios for IRL shipments, DOE develops a "10-percent lumen increase," in which DOE assumes that a portion of residential consumers of IRL will buy a more efficacious lamp at the same wattage as in the base case. This incorporation of non-energy-saving lamp designs results in an overall higher lumen output per IRL in the residential sector. To quantify the percentage of consumers that purchase same-wattage lamp designs, DOE assumes that the average initial lumen output of IRL of the standards-cases is 10 percent higher than that of the base case. DOE does not model this sensitivity scenario in the commercial sector. Shipment results for the 10-percent lumen increase sensitivity scenarios are presented in Appendix 9A of this TSD. In addition to modeling these three scenarios, DOE's shipment spreadsheet also allows for the user to generate custom inputs into the base case and standards-case market-share matrices. In addition to making available all lamp designs discussed above (both reduced-wattage and same-wattage lamp designs), the spreadsheet is also capable of modeling an increased or decreased shift toward non-IRL technologies in the standards-case.

10.4.2.2 Standards-Case Market-Share Matrices

Similar to the base case, DOE constructs market-share matrices to characterize lamp shipments in the standards-case. Table 10.58 through Table 10.61 display the lower- and upper-bound scenario market-share matrices for IRL shipments in each the commercial and residential sectors. These market-share matrices provide the same lamp designs as the base case market-share matrices. However, in the standards-case, some lamp designs are not standards-compliant and are therefore precluded from being shipped beginning in 2012. In the standards-case, standards-compliant lamps do not occupy all IRL sockets until the lamps purchased before 2012 fail. For example, the longest-lived residential IRL in the base case has a service life of 3.4 years. Therefore, standards-compliant lamps will not occupy all IRL sockets until about 2015. For this reason, the residential standards-case market-share matrix, representing the percentage of sockets occupied by specific IRL, is given in 2015 and 2042. Because the longest-lived commercial IRL in the base case has a service life of 1.7 years, the commercial standards-case market-share matrix is given in 2013 and 2042. Table 10.57 describes the inputs to the base case and standards-case IRL market-share matrices for the commercial and residential sectors.

Table 10.58 displays the commercial standards-case market-share matrix for the Shift, Product Substitution scenario.   As discussed earlier, in the base case, the commercial IRL market is composed mostly of halogen lamps. At TSL1 halogen IRL are no longer standards-compliant and consumers purchasing halogen-type IRL purchase improved halogen technology. Since these matrices represent the Shift scenario, those consumers already purchasing efficient lamp products shift to purchase even more efficient ones. (In the Roll-up scenario, consumers already purchasing standards-compliant lamps continue to purchase products at the same efficiency level. Table 10.60 displays the Roll-up, No Product Substitution scenario.) At TSL2 only long-life HIR and improved halogen lamps with a reduced-wattage can be sold. At TSL3 only HIR lamps are standards-compliant. TSL4 and TSL5 allow only the most efficient HIR lamps. In the commercial sector, DOE assumed that all institutions wishing to convert to R-CFL given its shortcomings (such as lower color quality) do so before 2012. Therefore, there is no additional movement to R-CFL in response to standards.

Table 10.59 displays the residential standards-case market-share matrix for the Shift, Product Substitution scenario. As discussed earlier, DOE assumes that the entire residential market purchases halogen IRL in the base case. At all subsequent TSLs, consumers usually choose the least costly standards-compliant lamp. For the residential sector, DOE incorporated additional movement to R-CFL. DOE calculated simple payback periods comparing R-CFL to the baseline halogen and R-CFL to the higher-efficiency lamp designs. It used these payback period calculations to determine incremental market penetrations. DOE assumes that some consumers choose to purchase the less efficient 65W BR lamp, which is exempted from standards, because of the difference in price. At TSL1, almost the entire residential market is composed of improved halogen IRL, with a small portion purchasing reflector CFL or 65W BR lamps. At TSL2, consumers start to shift to HIR lamps, so that at TSL3 the majority residential market is purchasing HIR technology. At TSL4, the residential IRL market is composed of predominantly improved HIR lamps. TSL5 represents a “max-tech” HIR lamp, which has a further improved reflective coating, IR coating, or filament design.

Table 10.57 Description of Base Case and Standards-Case IRL Market-Share Matrices

Case	Input Description
Base	*Technology mix of lamp designs in the lamp stock in 2011 and 2042
Standards	* Technology mix of lamp designs in the lamp stock in 2013 (commercial) or 2015 (residential) and 2042.

* Note: Because CFL penetration into the lamp stock is changing over the analysis period, lamp purchases for lamp replacement purposes are not necessarily the same as the retiring lamp.

Table 10.58 Standards-Case Market-Share Matrix for Commercial IRL Sockets (Shift, Product Substitution Scenario)

TSL	Lamp Design	EL	Installed Lamp Price	Stock in 2011*	Stock in 2013**	Stock in 2042
				%	%	%
Base Case	90W, 14.6 lm/W, 2500 hrs, Halogen	0	6.20	32		19
	75W, 14.0 lm/W, 2500 hrs, Halogen		6.20	25		15
	50W, 12.6 lm/W, 3000 hrs, Halogen		5.59	21		12
	83W, 15.9 lm/W, 6000 hrs, Long Life HIR	2	7.76	2		5
	69W, 15.3 lm/W, 6000 hrs, Long Life HIR		7.76	2		4
	46W, 13.5 lm/W, 6000 hrs, Long Life HIR		7.15	1		3
	79W, 16.6 lm/W, 3000 hrs, Improved Halogen		7.58	1		2
	66W, 15.9 lm/W, 3000 hrs, Improved Halogen		7.58	1		2
	45W, 14 lm/W, 3000 hrs, Improved Halogen		6.98	1		1
	70W, 18 lm/W, 3000 hrs, HIR	3	7.76	4		10
	60W, 17.5 lm/W, 3000 hrs, HIR		7.76	3		8
	42W, 15.1 lm/W, 3000 hrs, HIR		7.15	3		7
	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	9.08	2		5
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		9.08	2		4
	40W, 17 lm/W, 4000 hrs, Improved HIR		8.47	1		3
	Total			**100**		**100**
TSL 1	86W, 15.3 lm/W, 2500 hrs, Improved Halogen	1	7.14		31	19
	72W, 14.6 lm/W, 2500 hrs, Improved Halogen		7.14		24	15
	48W, 13.2 lm/W, 3000 hrs, Improved Halogen		6.53		15	7
	83W, 15.9 lm/W, 6000 hrs, Long Life HIR	2	7.76		2	5
	69W, 15.3 lm/W, 6000 hrs, Long Life HIR		7.76		2	4
	46W, 13.5 lm/W, 6000 hrs, Long Life HIR		7.15		2	3
	79W, 16.6 lm/W, 3000 hrs, Improved Halogen		7.58		1	2
	66W, 15.9 lm/W, 3000 hrs, Improved Halogen		7.58		1	2
	45W, 14 lm/W, 3000 hrs, Improved Halogen		6.98		1	1
	70W, 18 lm/W, 3000 hrs, HIR	3	7.76		4	10
	60W, 17.5 lm/W, 3000 hrs, HIR		7.76		3	8
	42W, 15.1 lm/W, 3000 hrs, HIR		7.15		3	7
	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	9.08		2	5
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		9.08		2	4
	40W, 17 lm/W, 4000 hrs, Improved HIR		9.47		2	3
	65W, 9.5 lm/W, 2000 hrs, BR30 Incandescent IRL		2.54		5	5
	Total				**100**	**100**
TSL 2	83W, 15.9 lm/W, 6000 hrs, Long Life HIR	2	7.76		9	6
	69W, 15.3 lm/W, 6000 hrs, Long Life HIR		7.76		7	4
	46W, 13.5 lm/W, 6000 hrs, Long Life HIR		7.15		7	4
	79W, 16.6 lm/W, 3000 hrs, Improved Halogen		7.58		21	13
	66W, 15.9 lm/W, 3000 hrs, Improved Halogen		7.58		17	10
	45W, 14 lm/W, 3000 hrs, Improved Halogen		6.98		11	6
	70W, 18 lm/W, 3000 hrs, HIR	3	7.76		4	7
	60W, 17.5 lm/W, 3000 hrs, HIR		7.76		3	6
	42W, 15.1 lm/W, 3000 hrs, HIR		7.15		2	5
	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	9.08		4	10
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		9.08		4	8
	40W, 17 lm/W, 4000 hrs, Improved HIR		8.47		3	7
	60W, 21 lm/W, 4200 hrs, Improved HIR Plus	5	9.65		2	5
	52W, 20.3 lm/W, 4200 hrs, Improved HIR Plus		9.65		2	4

	40W, 19.1 lm/W, 4200 hrs, Improved HIR Plus		9.04		2	3
	65W, 9.5 lm/W, 2000 hrs, BR30 Incandescent IRL		2.54		2	2
	Total				**100**	**100**
TSL 3	70W, 18 lm/W, 3000 hrs, HIR	3	7.76		31	18
	60W, 17.5 lm/W, 3000 hrs, HIR		7.76		24	14
	42W, 15.1 lm/W, 3000 hrs, HIR		7.15		17	10
	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	9.08		4	7
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		9.08		3	6
	40W, 17 lm/W, 4000 hrs, Improved HIR		8.47		2	5
	60W, 21 lm/W, 4200 hrs, Improved HIR Plus	5	9.65		7	15
	52W, 20.3 lm/W, 4200 hrs, Improved HIR Plus		9.65		5	12
	40W, 19.1 lm/W, 4200 hrs, Improved HIR Plus		9.04		4	10
	65W, 9.5 lm/W, 2000 hrs, BR30 Incandescent IRL		2.54		3	3
	Total				**100**	**100**
TSL 4	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	9.08		31	18
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		9.08		24	14
	40W, 17 lm/W, 4000 hrs, Improved HIR		8.47		19	11
	60W, 21 lm/W, 4200 hrs, Improved HIR Plus	5	9.65		10	23
	52W, 20.3 lm/W, 4200 hrs, Improved HIR Plus		9.65		8	18
	40W, 19.1 lm/W, 4200 hrs, Improved HIR Plus		9.04		7	15
	65W, 9.5 lm/W, 2000 hrs, BR30 Incandescent IRL	0	2.54		1	1
	Total				**100**	**100**
TSL 5	60W, 21 lm/W, 4200 hrs, Improved HIR Plus	5	9.65		41	41
	52W, 20.3 lm/W, 4200 hrs, Improved HIR Plus		9.65		32	32
	40W, 19.1 lm/W, 4200 hrs, Improved HIR Plus		9.04		24	24
	65W, 9.5 lm/W, 2000 hrs, BR30 Incandescent IRL		2.54		3	3
	Total				**100**	**100**

*Base-case input only.

**Standards-Case input only.

Table 10.59 Standards-Case Market-Share Matrix, For Residential IRL Sockets (Shift Product Substitution Scenario)

TSL	Lamp Design	EL	Installed Lamp Price	Stock in 2011*	Stock in 2015**	Stock in 2042
				%	%	%
Base Case	90W, 14.6 lm/W, 2500 hrs, Halogen	0	5.13	41		41
	75W, 14.0 lm/W, 2500 hrs, Halogen		5.13	32		32
	50W, 12.6 lm/W, 3000 hrs, Halogen		4.53	27		27
	Total			**100**		**100**
TSL 1	86W, 15.3 lm/W, 2500 hrs, Improved Halogen	1	6.07		40	40
	72W, 14.6 lm/W, 2500 hrs, Improved Halogen		6.07		31	31
	48W, 13.2 lm/W, 3000 hrs, Improved Halogen		5.46		22	22
	26W, 50 lm/W, 8000 hrs, Reflector CFL		7.69		1	1
	23W, 52.2 lm/W, 8000 hrs, Reflector CFL		7.69		1	1
	16W, 46.9 lm/W, 8000 hrs, Reflector CFL		6.33		1	1
	65W, 9.5 lm/W, 2000 hrs, BR30 Incandescent IRL		1.48		4	4
	Total				**100**	**100**
TSL 2	83W, 15.9 lm/W, 6000 hrs, Long Life HIR	2	6.70		12	12
	69W, 15.3 lm/W, 6000 hrs, Long Life HIR		6.70		9	9
	46W, 13.5 lm/W, 6000 hrs, Long Life HIR		6.09		5	5
	79W, 16.6 lm/W, 3000 hrs, Improved Halogen		6.52		28	28

	66W, 15.9 lm/W, 3000 hrs, Improved Halogen		6.52		21	21
	45W, 14 lm/W, 3000 hrs, Improved Halogen		5.92		13	13
	26W, 50 lm/W, 8000 hrs, Reflector CFL		7.69		2	2
	23W, 52.2 lm/W, 8000 hrs, Reflector CFL		7.69		2	2
	16W, 46.9 lm/W, 8000 hrs, Reflector CFL		6.33		2	2
	65W, 9.5 lm/W, 2000 hrs, BR30 Incandescent IRL		1.48		6	6
	Total				**100**	**100**
TSL 3	70W, 18 lm/W, 3000 hrs, HIR	3	6.70		39	39
	60W, 17.5 lm/W, 3000 hrs, HIR		6.70		30	30
	42W, 15.1 lm/W, 3000 hrs, HIR		6.09		17	17
	26W, 50 lm/W, 8000 hrs, Reflector CFL		7.69		2	2
	23W, 52.2 lm/W, 8000 hrs, Reflector CFL		7.69		2	2
	16W, 46.9 lm/W, 8000 hrs, Reflector CFL		6.33		3	3
	65W, 9.5 lm/W, 2000 hrs, BR30 Incandescent IRL		1.48		7	7
	Total				**100**	**100**
TSL 4	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	8.02		37	37
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		8.02		28	28
	40W, 17 lm/W, 4000 hrs, Improved HIR		7.41		10	10
	26W, 50 lm/W, 8000 hrs, Reflector CFL		7.69		4	4
	23W, 52.2 lm/W, 8000 hrs, Reflector CFL		7.69		4	4
	16W, 46.9 lm/W, 8000 hrs, Reflector CFL		6.33		3	3
	65W, 9.5 lm/W, 2000 hrs, BR30 Incandescent IRL		1.48		14	14
	Total				**100**	**100**
TSL 5	60W, 21 lm/W, 4200 hrs, Improved HIR Plus	5	8.59		37	37
	52W, 20.3 lm/W, 4200 hrs, Improved HIR Plus		8.59		28	28
	40W, 19.1 lm/W, 4200 hrs, Improved HIR Plus		7.98		8	8
	26W, 50 lm/W, 8000 hrs, Reflector CFL		7.69		4	4
	23W, 52.2 lm/W, 8000 hrs, Reflector CFL		7.69		4	4
	16W, 46.9 lm/W, 8000 hrs, Reflector CFL		6.33		3	3
	65W, 9.5 lm/W, 2000 hrs, BR30 Incandescent IRL		1.48		16	16
	Total				**100**	**100**

*Base-case input only.
**Standards-Case input only.

Table 10.60 Standards-Case Market-Share Matrix for Commercial IRL Sockets (Roll-up, No Product Substitution Scenario)

TSL	Lamp Design	EL	Installed Lamp Price	Stock in 2011*	Stock in 2013**	Stock in 2042
				%	%	%
Base Case	90W, 14.6 lm/W, 2500 hrs, Halogen	0	6.20	32		19
	75W, 14.0 lm/W, 2500 hrs, Halogen		6.20	25		15
	50W, 12.6 lm/W, 3000 hrs, Halogen		5.59	21		12
	83W, 15.9 lm/W, 6000 hrs, Long Life HIR	2	7.76	2		5
	69W, 15.3 lm/W, 6000 hrs, Long Life HIR		7.76	2		4
	46W, 13.5 lm/W, 6000 hrs, Long Life HIR		7.15	1		3
	79W, 16.6 lm/W, 3000 hrs, Improved Halogen		7.58	1		2
	66W, 15.9 lm/W, 3000 hrs, Improved Halogen		7.58	1		2
	45W, 14 lm/W, 3000 hrs, Improved Halogen		6.98	1		1
	70W, 18 lm/W, 3000 hrs, HIR	3	7.76	4		10
	60W, 17.5 lm/W, 3000 hrs, HIR		7.76	3		8
	42W, 15.1 lm/W, 3000 hrs, HIR		7.15	3		7
	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	9.08	2		5

	55W, 19.1 lm/W, 4000 hrs, Improved HIR		9.08	2		4
	40W, 17 lm/W, 4000 hrs, Improved HIR		8.47	1		3
	Total			**100**		**100**
TSL 1	86W, 15.3 lm/W, 2500 hrs, Improved Halogen	1	7.14		31	19
	72W, 14.6 lm/W, 2500 hrs, Improved Halogen		7.14		24	15
	48W, 13.2 lm/W, 3000 hrs, Improved Halogen		6.53		20	12
	83W, 15.9 lm/W, 6000 hrs, Long Life HIR	2	7.76		2	5
	69W, 15.3 lm/W, 6000 hrs, Long Life HIR		7.76		2	4
	46W, 13.5 lm/W, 6000 hrs, Long Life HIR		7.15		1	3
	79W, 16.6 lm/W, 3000 hrs, Improved Halogen		7.58		1	2
	66W, 15.9 lm/W, 3000 hrs, Improved Halogen		7.58		1	2
	45W, 14 lm/W, 3000 hrs, Improved Halogen		6.98		1	1
	70W, 18 lm/W, 3000 hrs, HIR	3	7.76		4	10
	60W, 17.5 lm/W, 3000 hrs, HIR		7.76		4	8
	42W, 15.1 lm/W, 3000 hrs, HIR		7.15		3	7
	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	9.08		2	5
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		9.08		2	4
	40W, 17 lm/W, 4000 hrs, Improved HIR		9.47		1	3
	Total				**100**	**100**
TSL 2	83W, 15.9 lm/W, 6000 hrs, Long Life HIR	2	7.76		10	8
	69W, 15.3 lm/W, 6000 hrs, Long Life HIR		7.76		8	6
	46W, 13.5 lm/W, 6000 hrs, Long Life HIR		7.15		7	5
	79W, 16.6 lm/W, 3000 hrs, Improved Halogen		7.58		24	18
	66W, 15.9 lm/W, 3000 hrs, Improved Halogen		7.58		19	14
	45W, 14 lm/W, 3000 hrs, Improved Halogen		6.98		16	12
	70W, 18 lm/W, 3000 hrs, HIR	3	7.76		4	10
	60W, 17.5 lm/W, 3000 hrs, HIR		7.76		4	8
	42W, 15.1 lm/W, 3000 hrs, HIR		7.15		3	7
	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	9.08		2	5
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		9.08		2	4
	40W, 17 lm/W, 4000 hrs, Improved HIR		8.47		1	3
	Total				**100**	**100**
TSL 3	70W, 18 lm/W, 3000 hrs, HIR	3	7.76		39	36
	60W, 17.5 lm/W, 3000 hrs, HIR		7.76		30	28
	42W, 15.1 lm/W, 3000 hrs, HIR		7.15		26	24
	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	9.08		2	5
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		9.08		2	4
	40W, 17 lm/W, 4000 hrs, Improved HIR		8.47		1	3
	Total				**100**	**100**
TSL 4	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	9.08		41	41
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		9.08		32	32
	40W, 17 lm/W, 4000 hrs, Improved HIR		8.47		27	27
	Total				**100**	**100**
TSL 5	60W, 21 lm/W, 4200 hrs, Improved HIR Plus	5	9.65		41	41
	52W, 20.3 lm/W, 4200 hrs, Improved HIR Plus		9.65		32	32
	40W, 19.1 lm/W, 4200 hrs, Improved HIR Plus		9.04		27	27
	Total				**100**	**100**

*Base-case input only.

**Standards-Case input only.

Table 10.61 Standards-Case Market-Share Matrix, For Residential IRL Sockets (Roll-up, No Product Substitution Scenario)

TSL	Lamp Design	TSL	Installed Lamp Price	Stock in 2011*	Stock in 2015**	Stock in 2042
				%	%	%
Base Case	90W, 14.6 lm/W, 2500 hrs, Halogen	0	5.13	41		41
	75W, 14.0 lm/W, 2500 hrs, Halogen		5.13	32		32
	50W, 12.6 lm/W, 3000 hrs, Halogen		4.53	27		27
	Total			**100**		**100**
TSL 1	86W, 15.3 lm/W, 2500 hrs, Improved Halogen	1	6.07		41	41
	72W, 14.6 lm/W, 2500 hrs, Improved Halogen		6.07		32	32
	48W, 13.2 lm/W, 3000 hrs, Improved Halogen		5.46		27	27
	Total				**100**	**100**
TSL 2	83W, 15.9 lm/W, 6000 hrs, Long Life HIR	2	6.70		12	12
	69W, 15.3 lm/W, 6000 hrs, Long Life HIR		6.70		10	10
	46W, 13.5 lm/W, 6000 hrs, Long Life HIR		6.09		8	8
	79W, 16.6 lm/W, 3000 hrs, Improved Halogen		6.52		29	29
	66W, 15.9 lm/W, 3000 hrs, Improved Halogen		6.52		22	22
	45W, 14 lm/W, 3000 hrs, Improved Halogen		5.92		19	19
	Total				**100**	**100**
TSL 3	70W, 18 lm/W, 3000 hrs, HIR	3	6.70		41	41
	60W, 17.5 lm/W, 3000 hrs, HIR		6.70		32	32
	42W, 14.8 lm/W, 3000 hrs, HIR		6.09		27	27
	Total				**100**	**100**
TSL 4	66W, 19.8 lm/W, 4000 hrs, Improved HIR	4	8.02		41	41
	55W, 19.1 lm/W, 4000 hrs, Improved HIR		8.02		32	32
	40W, 17 lm/W, 4000 hrs, Improved HIR		7.41		27	27
	Total				**100**	**100**
TSL 5	60W, 21 lm/W, 4200 hrs, Max Tech HIR	5	8.59		41	41
	52W, 20.3 lm/W, 4200 hrs, Max Tech HIR		8.59		32	32
	40W, 19.1 lm/W, 4200 hrs, Max Tech HIR		7.98		27	27
	Total				**100**	**100**

*Base-case input only.
**Standards-Case input only.

10.5 RESULTS

The following sections show the shipments forecasts for the various TSLs for GSFL and IRL.

10.5.1 General Service Fluorescent Lamps

10.5.1.1 Shipments Forecasts: Base and Standards-Cases

Figure 10.5.1 through Figure 10.5.6 present the shipments forecasts for the base case and standards-cases for 4-foot medium bipin, 8-foot single pin slimline, 8-foot recessed double contact HO, 4-foot T5 standard output and high output lamps in the Existing Technologies, Shift, High Expertise Scenario and the Emerging Technologies, Roll-up, Market-Segment Based expertise scenario. These reflect the upper- and lower-bound energy scenarios.

Quantities of lamp shipments depend on the occurrence of the lamp purchasing events: lamp failure, ballast failure, ballast retrofit, and new construction. As discussed earlier, instead of using each particular lamp design's individual lifetime to time lamp replacements, DOE uses an average lifetime for each analyzed lamp type. For this reason, the rate of lamp replacement does not change between the Shift and Roll-up, High and Market Segment-Based expertise standards-case scenarios. In addition, because ballast lifetime does not change, the rate of ballast failure is also the same in both scenarios. Since the ballast retrofit rate is an input external to the market-share matrices, the rate of occurrence of ballast retrofits are the same for both scenarios. Using the Shift or Roll-up scenario and High or Market Segment-Based expertise scenario does affect the average lumen output of the lamp-and-ballast systems shipped, and therefore the quantities of systems shipped due to renovation, fixture replacement, and new construction. However, these market segments compose a fairly small portion of overall lamp shipments. Therefore, though presented separately in the following tables when different, the upper- and lower-bound scenarios can result in similar quantities of shipments for all GSFL lamp types.

As seen in Figure 10.5.1 and Figure 10.5.2, the standards-case forecasts of 4-foot medium bipin lamps experience similar trends as the base case, though at modified rates. In both the base case and standards-case, the shipments forecast depicts a decrease in shipments of 4-foot T12 medium bipin systems, as only 10 percent of these retiring systems are replaced with the same system. This trend is matched by a corresponding increase in shipments of 4-foot T8 medium bipin systems due to their replacement of T12 systems, an increasing number of lamps per home, and growth in lumen demand in the commercial sector. Specifically, 4-foot T8 medium bipin shipments increase because they replace 80 percent of 8-foot T12 single pin slimline systems. Additionally, with increasing trial standard levels, the early retrofit rates of 4-foot T12 medium bipin systems in the commercial sector increase. In the residential sector, at higher TSLs a greater portion of consumers replace their retired T12 systems with T8 systems; consequently, a greater proportion of residential shipments are T8s as opposed to T12s at higher TSLs. Because 4-foot T12 medium bipin and 8-foot T12 single pin slimline lamps are no longer standards-compliant at EL4 and EL5, these systems are automatically retrofitted upon lamp failure (i.e., there are no T12 lamp shipments at these levels). Both these voluntary retrofits and standard-induced retrofits increase shipments of 4-foot T8 medium bipin lamps and decrease shipments of 4-foot T12 medium bipin lamps.

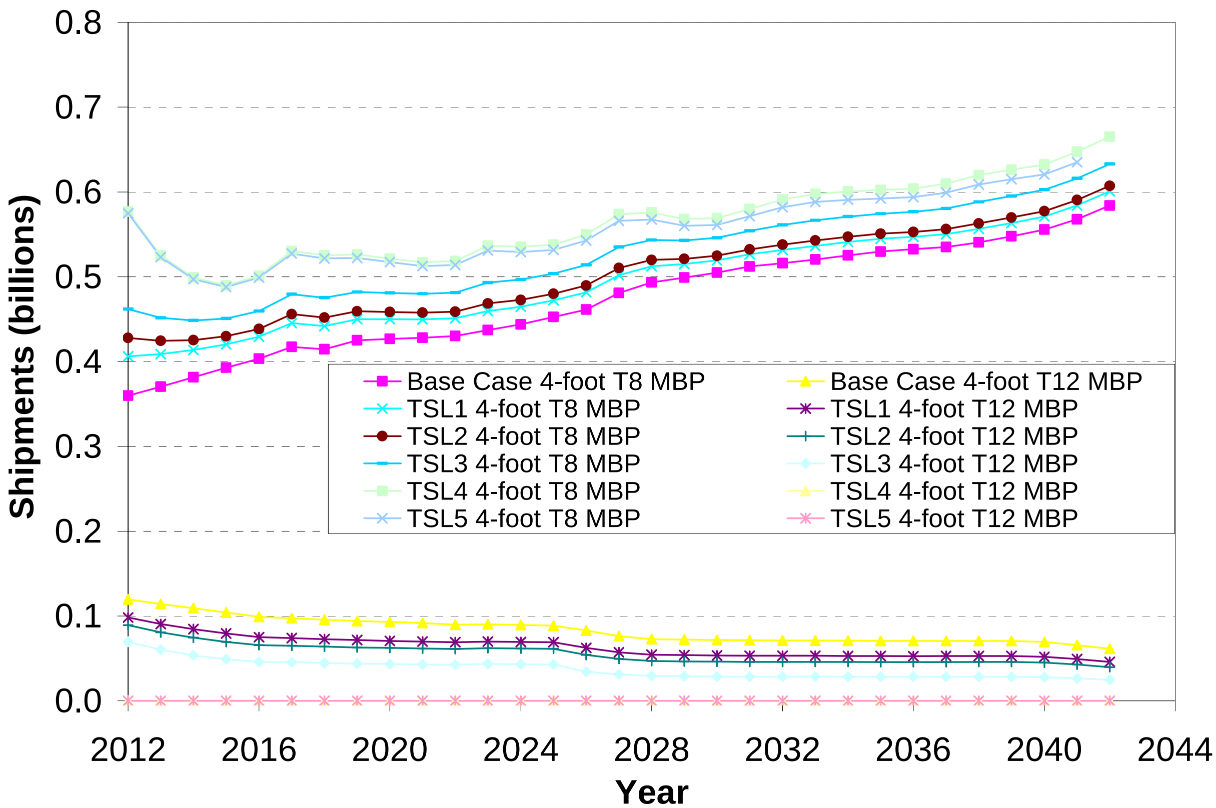

Figure 10.5.1 Four-Foot Medium Bipin Base Case and Standards-Case Shipments Forecasts (Existing Technologies, Shift, High Expertise Scenario)

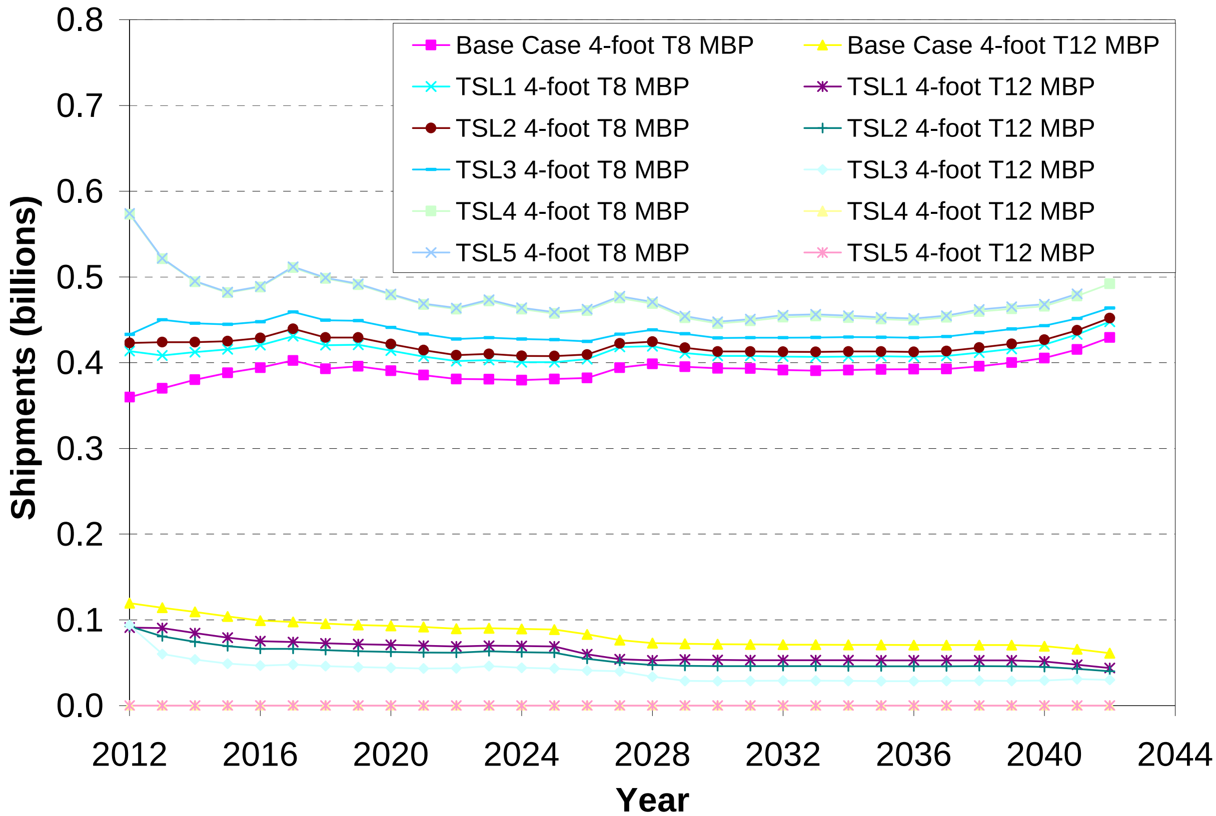

Figure 10.5.2 Four-Foot Medium Bipin Base Case and Standards-Case Shipments Forecasts (Emerging Technologies, Roll-up, Market Segment-Based Expertise Scenario)

As seen in Figure 10.5.3, the standards-case forecasts of 8-foot single pin slimline lamps experience similar trends as the base case, though at modified rates. In both the base case and standards-case, the shipment forecast depicts a decrease in shipments of 8-foot T12 single pin slimline lamps, as only 10 percent of retiring 8-foot T12 single pin slimline magnetic systems are replaced with 8-foot T12 electronic systems. Initially, this trend is matched by a corresponding increase in shipments of 8-foot T8 single pin slimline lamps due to the replacement of 10 percent of 8-foot T12 single pin slimline systems with 8-foot T8 single pin slimline systems. However, further into the analysis period, the stock of 8-foot 12 systems declines such that there are not enough retiring T12 systems each year for T8 systems to replace and continue positive shipment growth. Thus, around 2020—the precise year varies by TSL, 8-foot T8 shipments peak and begin to fall. Additionally, as with 4-foot medium bipin systems, the early retrofit rates of 8-foot T12 single pin slimline systems increase with increasingly TSLs. Because 8-foot T12 single pin slimline lamps are no longer standards-compliant at TSL4 and TSL5, these systems are automatically retrofitted upon lamp failure (i.e., there are no T12 lamp shipments at these TSLs). There is no difference between the upper- and lower-bound scenarios primarily because 8-foot single pin slimline lamps are not modeled to service fixture replacement, renovation, and new construction needs, and because average lifetime does not vary by scenario.

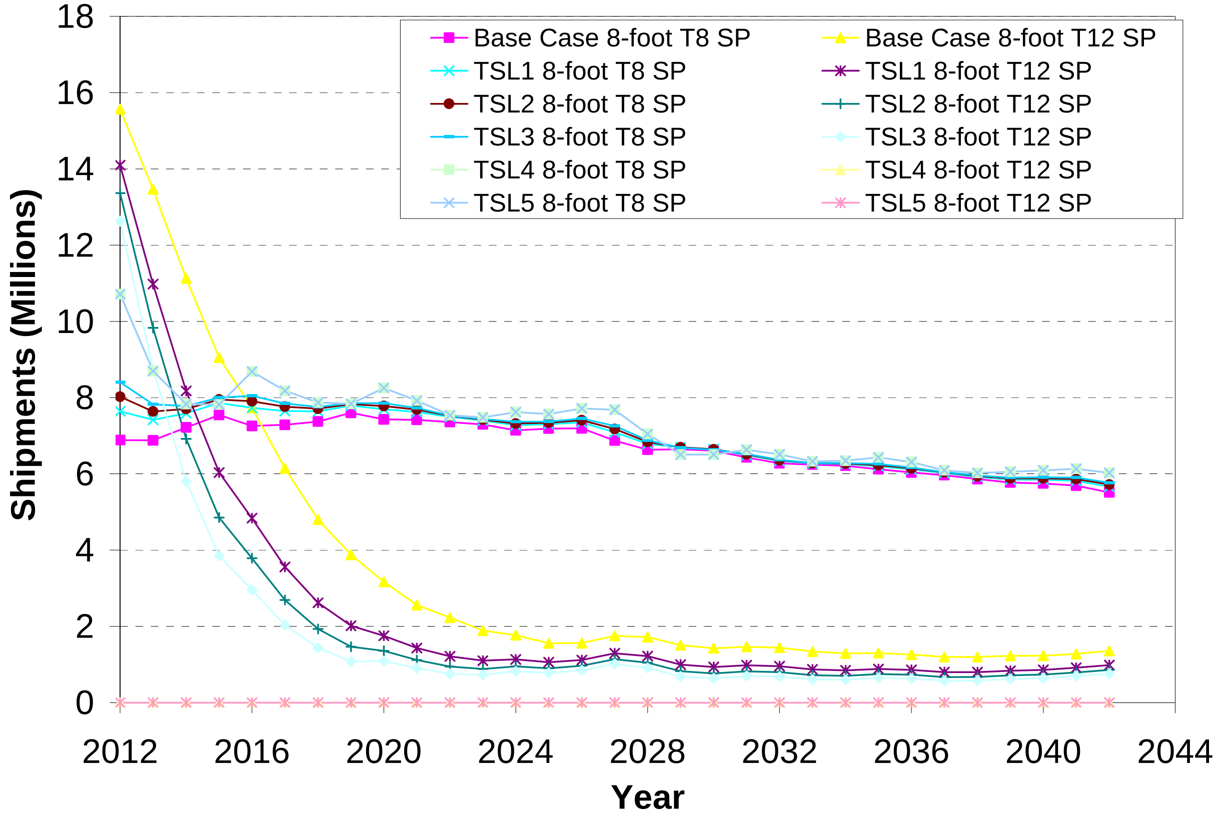

Figure 10.5.3 Eight-Foot Single Pin Slimline Base Case and Standards-Case Shipments Forecasts (Existing Technologies, Shift, High Expertise and Emerging Technologies, Roll-up, Market Segment-Based Expertise Scenarios)

As seen in Figure 10.5.4, the standards-case shipment forecasts of 8-foot recessed double contact HO lamps are identical to the base case at TSL1, TSL2, and TSL3. The only difference between the base case and these standards levels is that higher efficacy lamps are being shipped in the standards-cases. However, because 8-foot T12 recessed double contact HO lamps are no longer standards-compliant at EL4 and EL5, these systems are automatically retrofitted upon lamp failure to 8-foot T8 recessed double contact HO systems (i.e., there are no shipments at these TSLs). These ballast retrofits and lamp replacements are a one-to-one replacement, resulting in approximately same quantity of T8 shipments in the standards-case as T12 shipments in the base case. They are not exactly the same because 8-foot RDC HO T8 lamps have longer lifetimes their T12 counterparts. There is no difference between the upper- and lower-bound scenarios primarily because 8-foot recessed double contact HO lamps are not modeled to service fixture replacement, renovation, and new construction needs.

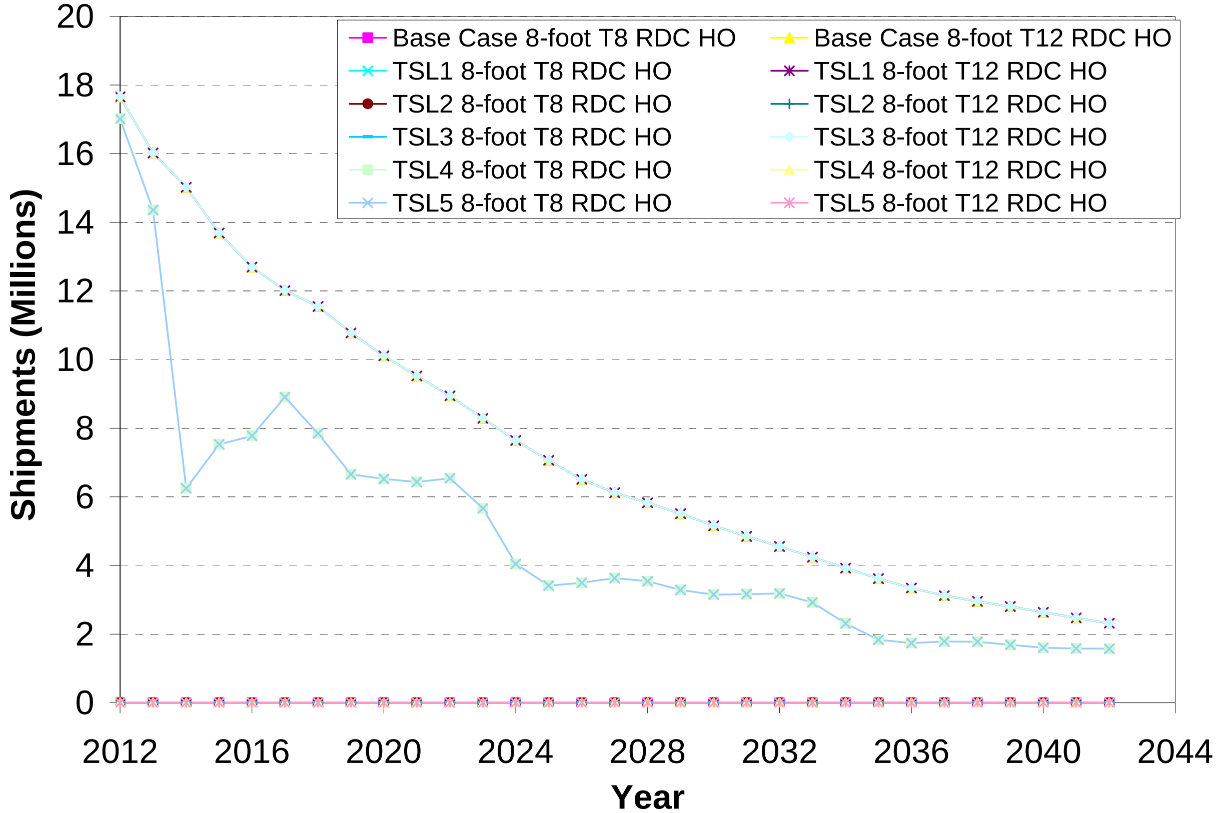

Figure 10.5.4 Eight-Foot Recessed Double Contact High Output Base Case and Standards-Case Shipments Forecasts (Existing Technologies, Shift, High Expertise and Emerging Technologies, Roll-up, Market Segment-Based Expertise Scenarios)

As seen in Figure 10.5.5 and Figure 10.5.6, the standards-case does not significantly the base case forecasts of 4-foot T5 MiniBP standard output and high output lamps. These two product classes experience similar trends as the base case at slightly modified rates. This effect is largely due to the fact that DOE does not directly assume additional shifts to or from these product classes in the standards-case.

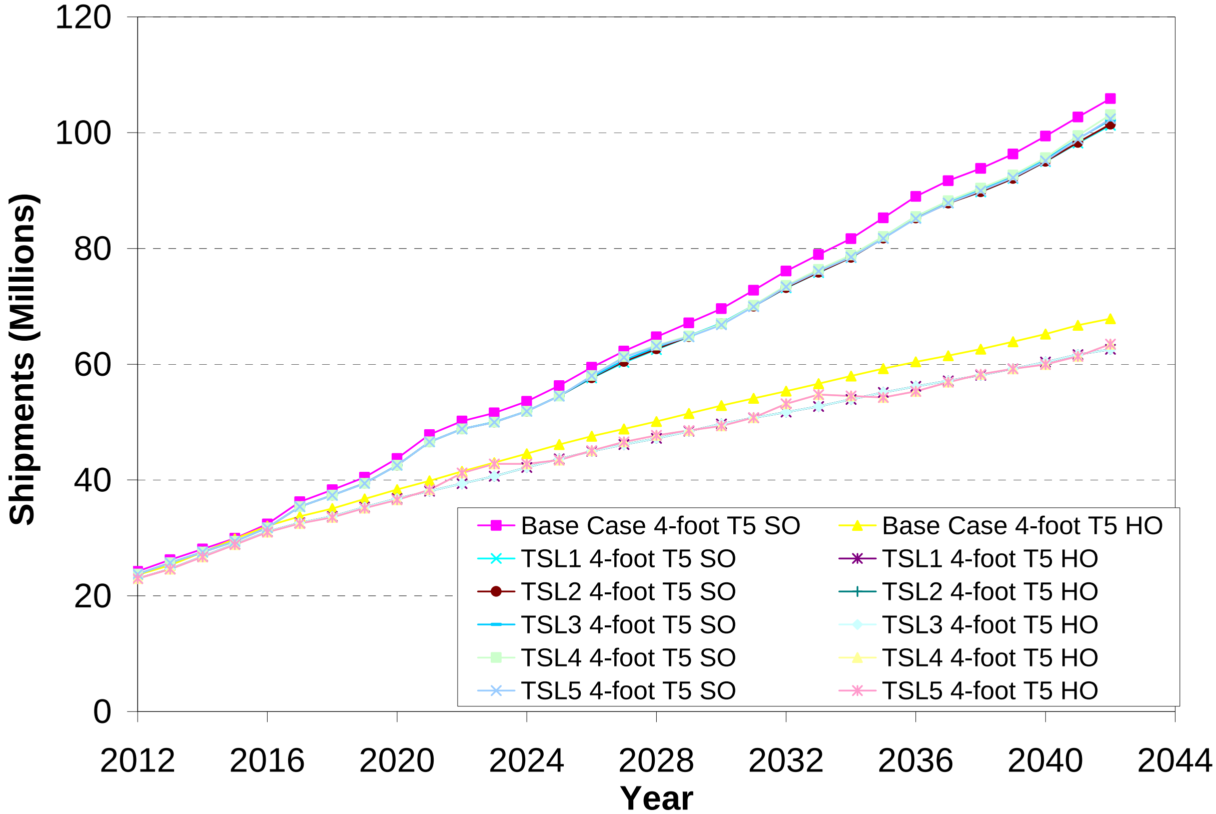

Figure 10.5.5 Four-Foot T5 MiniBP Standard Output and High Output Base Case and Standards-Case Shipments Forecasts (Existing Technologies, Shift, High Expertise Scenario)

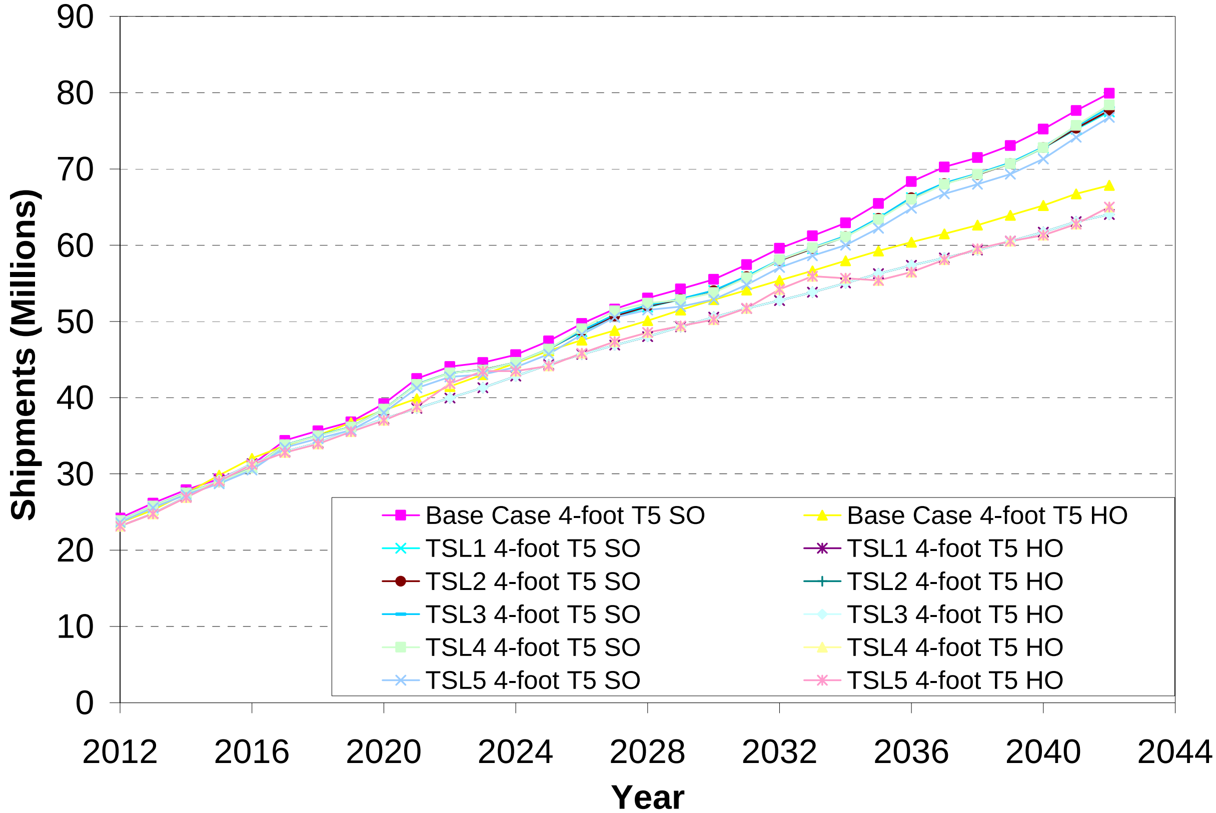

Figure 10.5.6 Four-Foot MiniBP Base Case and Standards-Case Shipments Forecasts (Emerging Technologies, Roll-up, Market Segment-Based Expertise Scenario)

10.5.1.2 Cumulative Shipments Impacts (2012 – 2042)

Table 10.62 through Table 10.69 show the cumulative shipments impacts from 2012 to 2042 caused by each of the five standards-cases considered for 4-foot medium bipin, 8-foot single pin slimline, 8-foot recessed double contact HO, and 4-foot T5 standard output and high output lamps under the Existing Technologies, Shift, High expertise and Emerging Technologies, Roll-up, Market Segment-Based expertise scenarios. As discussed earlier, quantities of lamp shipments in the standards-case are based on lamp replacement rates, ballast replacement rates, shipments due to new construction, and ballast retrofit rates. However, because all lamps within a particular product class are assumed to have the same lifetime, lamp replacement rates in the base case and standards-case are equivalent. In addition, because the ballast lifetime never varies within a particular market sector, ballast replacement rates are equivalent in the base case and standards-case. The only aspects that do vary are the shipments due to new construction (because average lumen outputs per system vary),and ballast retrofit rates (for 4-foot medium bipin and 8-foot single pin slimline systems).

Table 10.62 and Table 10.63 and show that as ballast retrofit rates increase with standard levels, 4-foot medium bipin cumulative lamp shipments generally increase as well. With higher retrofit rates, consumers are discarding their existing, working lamps and therefore must make more total lamp purchases. However, the average lumen output per system affects these cumulative shipments as well. For example, as seen in Table 10.62 a high average lumen output per lamp system at TSL5 results in fewer shipments due to new construction, and therefore fewer cumulative shipments.

Table 10.62 Four-Foot Medium Bipin Lamp: Cumulative Shipments Impacts Caused by Standards, 2012–2042 (Existing Technologies, Shift, High Expertise Scenario)

Trial Standard Level	Cumulative Impacts (millions of lamps)
1	40.7
2	52.9
3	226.9
4	278.8
5	61.5

Table 10.63 Four-Foot Medium Bipin Lamp: Cumulative Shipments Impacts Caused by Standards, 2012–2042 (Emerging Technologies, Roll-up, Market Segment-Based Expertise Scenario)

Trial Standard Level	Cumulative Impacts (millions of lamps)
1	40.7
2	52.9
3	82.5
4	(39.2)
5	13.3

Because there is no assumed 8-foot single pin slimline and 8-foot recessed double contact HO markets due to new construction, cumulative shipment impacts do not vary when changing the technology mix of shipments. Table 10.64 and Table 10.65 present cumulative shipments impacts for both the lower- and upper-bound scenarios. As seen in Table 10.64, cumulative impacts decrease with increasing trial standard levels because of the large number of 8-foot single pin slimline systems that experience an early turnover to 4-foot medium bipin systems. Cumulative impacts decrease at TSL4 and TSL5 for 8-foot recessed double contact systems when standards phase out T12 lamps of this type. In turn, while the shipment model in the industrial sector does not incorporate retrofits, cumulative shipment impacts for 8-foot recessed double contact HO lamps exist because of there is a ballast lifetime difference between T8 and T12 systems of this product class, resulting in the cumulative impacts show in Table 10.65.

Table 10.64 Eight-Foot Single Pin Slimline: Cumulative Shipments Impacts Caused by Standards, 2012–2042 (Existing Technologies, Shift, High Lighting Expertise Scenario)

Trial Standard Level	Cumulative Impacts (millions of lamps)
1	(26.6)
2	(36.0)
3	(43.7)
4	(91.8)
5	(91.8)

Table 10.65 Eight-Foot Recessed Double Contact High Output: Cumulative Shipments Impacts Caused by Standards, 2012–2042 (Existing Technologies, Shift, High Expertise ScenariEmerging Technologies, Shift and Roll-up, Market Segment-Based Scenarios)

Trial Standard Level	Cumulative Impacts (millions of lamps)
1	0
2	0
3	0
4	(79.7)
5	(79.7)

As shown in Table 10.66 and Table 10.69, cumulative impacts on 4-foot T5 MiniBP standard and high output lamps are approximately equivalent for the Existing Technologies, Shift, High expertise and Emerging Technologies, Roll-up, Market Segment-Based scenarios because average lumen output increases only slightly in the Shift scenario. Impacts are roughly flat until TSL5 when a higher average lumen output causes fewer lamps to be shipped to service lumen demand. Similar to other product classes, at TSL4 and TSL5, shipment impacts decrease due to the higher average system lumen output of these lamps.

Table 10.66 Four-Foot T5 MiniBP Standard Output: Cumulative Shipments Impacts Caused by Standards, 2012–2042 (Existing Technologies, Shift, High Expertise Scenario)

Trial Standard Level	Cumulative Impacts (millions of lamps)
1	(70.1)
2	(69.5)
3	(64.3)
4	(60.5)
5	(66.1)

Table 10.67 Four-Foot T5 MiniBP Standard Output: Cumulative Shipments Impacts Caused by Standards, 2012–2042 (Existing Technologies, Shift, High Expertise Scenario)

Trial Standard Level	Cumulative Impacts (millions of lamps)
1	(39.9)
2	(39.3)
3	(37.2)
4	(37.7)
5	(62.5)

Table 10.68 Four-Foot T5 MiniBP High Output: Cumulative Shipments Impacts Caused by Standards, 2012–2042 (Existing Technologies, Shift, High Expertise Scenario)

Trial Standard Level	Cumulative Impacts (millions of lamps)
1	(86.9)
2	(86.9)
3	(86.9)
4	(79.9)
5	(79.9)

Table 10.69 Four-Foot T5 MiniBP High Output: Cumulative Shipments Impacts Caused by Standards, 2012–2042 (Emerging Technologies, Roll-up, Market Segment-Based Scenario)

Trial Standard Level	Cumulative Impacts (millions of lamps)
1	(62.5)
2	(62.5)
3	(62.5)
4	(55.3)
5	(55.3)

10.5.2 Incandescent Reflector Lamps

This section presents shipment results for the IRL shipment scenarios. The results for the 10-percent lumen increase sensitivity scenarios are presented in Appendix 10B.

10.5.2.1 Shipments Forecasts: Base and Standards-Cases

Figure 10.5.7 and Figure 10.5.8 present shipments forecasts for the base case and standards-cases for IRL. These two shipment forecasts can be characterized as the upper- and lower-bound energy savings scenarios.

Figure 10.5.7 displays the IRL base case in the Emerging Technologies scenario and the standards-case shipment forecasts for the Roll-up, no product substitution scenario. At TSL1, consumers who in the base case purchase halogen IRL (some of which are 2,500 hours), instead purchase improved halogen IRL (with a lifetime of 3,000 hours) in the standards-case. Similarly, at TSL2 all consumers purchase HIR IRL with a lifetime of 3,000 hours. Because the lifetimes of the TSL1 and TSL2 lamp designs are longer than those of the base case lamps, lamp replacements occur less frequently, thereby causing a reduction in shipments. The longer lifetimes (4,000 hours) of improved halogen lamps designs at TSL3 cause an even further reduction in IRL shipments. Similar trends occur at TSL4 and TSL5 as the lamps shipped at these standard levels are 4,000 hours and 4,200 hours in lifetime, respectively..

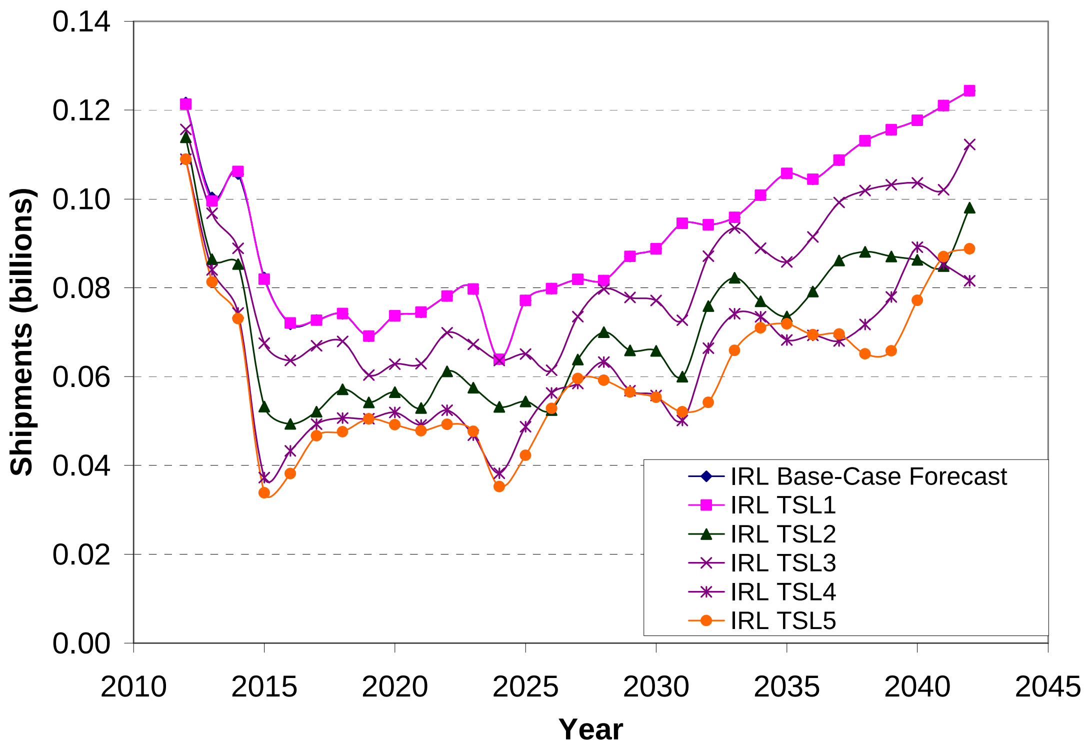

Figure 10.5.7 IRL Base Case and Standards-Case Shipment Forecasts (Emerging Technologies, Roll-up, No Product Substitution Scenario)

Figure 10.5.8 displays IRL shipments in Existing Technologies base case and shipments for the Shift, product substitution standards-case scenario. Again, shipments in the standards-cases are lower than the base case shipments due to the integration of longer lifetime lamp designs.

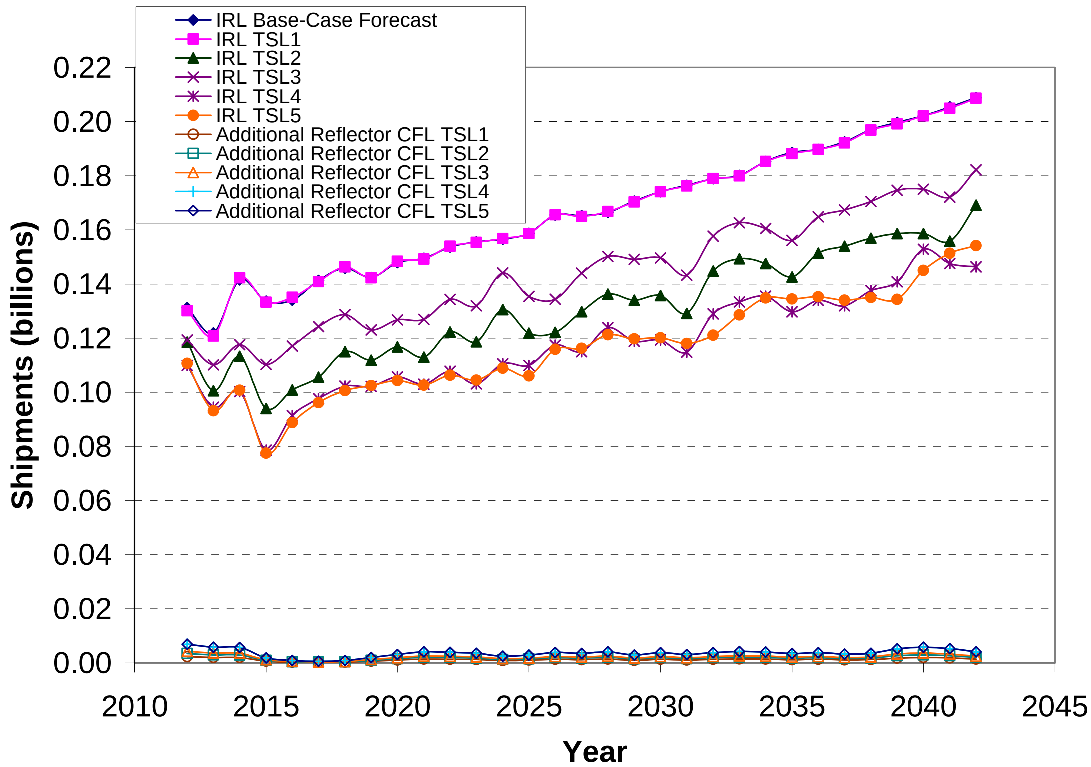

Figure 10.5.8 IRL Base Case and Standards-Case Shipments Forecasts (Existing Technologies, Shift, Product Substitution Scenario)

10.5.2.2 Cumulative Shipments Impacts (2012–2042)

Table 10.70 and Table 10.71 present cumulative shipment impacts the Existing Technologies, Shift, product substitution scenario and the Emerging Technologies, Roll-up, no product substitution scenario, respectively. Shipment impacts are associated with the increased lifetime of standards-case lamps. The longer the lifetime of standards-case lamps, the greater the impact on shipments due to fewer lamps needing to be replaced each year.

Table 10.70 Incandescent Reflector Lamps: Cumulative Shipments Impacts Caused by Standards, 2012–2042 (Existing Technologies, Shift, Product Substitution Scenario)

TSL	Existing Technologies, Shift, Product Substitution Scenario		
	IRL (non exempt)	65WBR30	RCFL
1	-0.003	0.307	0.039
2	-1.102	0.294	0.057
3	-0.697	0.332	0.070
4	-1.516	0.499	0.113
5	-1.538	0.661	0.113

Table 10.71 Incandescent Reflector Lamps: Cumulative Shipments Impacts Caused by Standards, 2012–2042 (Emerging Technologies, Roll-up, No Product Substitution)

TSL	Emerging Technologies, Roll-up, No Product Substitution Scenarios		
	IRL (non exempt)	65WBR30	RCFL
1	-0.001	0.000	0.000
2	-0.676	0.000	0.000
3	-0.329	0.000	0.000
4	-0.908	0.000	0.000
5	-0.987	0.000	0.000

REFERENCES

[1] National Electrical Manufacturers Association. 2006. No. 12 at p. 7. This written comment, document number 12, is available in Docket # EE–2006–STD–0131. For more information, contact Brenda Edwards-Jones at (202) 586-2945.

[2] RLW Analytics, Inc. "California Statewide Residential Lighting and Appliance Efficiency Saturation Survey." Sonoma, CA. August 2005. Last accessed on 9/29/08. www.calresest.com/docs/2005CLASSREPORT.pdf.

[3] RLW Analytics, Inc. "California Statewide Residential Lighting and Appliance Efficiency Saturation Survey." Sonoma, CA: RLW Analytics, Inc. http://www.calresest.com/index.cfm

[4] U.S. Census Bureau. Manufacturing, Mining, and Construction Statistics. "Net Privately Owned Housing Unit Starts." http://www.census.gov/const/startsan.pdf

[5] Multi-Year Program Plan FY'09 to FY'14: Solid-State Lighting Research and Development. Washington, D.C.: U.S. Department of Energy. www.netl.doe.gov/ssl/PDFs/SSLMYPP2008_web.pdf.

[6] Because they are based on an existing LED retrofit kit, DOE's projections did not consider innovations in form factor or OLED technology which could improve the possible payback period for solid-state lighting technologies

[7] DiLouie, Craig. "Introducing the T5 Lamp." Power Outlet. Vol. 4, No. 3.

[8] U.S. Census Bureau. Current Industrial Reports, Fluorescent Lamp Ballasts: 2005: Table 1. Summary of Shipments of Fluorescent Lamp Ballasts: 1995 to 2005. 2006. Washington, D.C. <http://www.census.gov/industry/1/mq335c055.pdf>.

[9] U.S. Census Bureau. Current Industrial Reports, Fluorescent Lamp Ballasts: 2005: Table 1. Summary of Shipments of Fluorescent Lamp Ballasts: 1992 to 2002. 2003. Washington, D.C. <http://www.census.gov/industry/1/mq335c025.pdf>.

[10] This written comment, document number 17, was submitted in response to the Energy Conservation Program for Commercial and Industrial Equipment: High-Intensity Discharge (HID) Lamps and is available in Docket # EE–DET-03-001.

[11] New York State Energy Research and Development Authority. *Incandescent Reflector Lamps Study of Proposed Energy Efficiency Standards for New York State*. 2006 (Last accessed October 7, 2006) <http://www.nyserda.org/publications/Report%2006-07-Complete%20report-web.pdf> The October 7, 2006 material from this website is available in Docket # EE–2006–STD–0131. For more information, contact Brenda Edwards-Jones at (202) 586-2945.